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"MINE EYES UNTO THE HILLS"

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Myitkyina, a small town on the Irrawaddy in Northern Burma has been much in the news lately and probably thousands of people who, three years ago had never heard of it, know now how to pronounce its name. It is sometimes dignified in the news by being termed a city, a title to which it has no real claim. Here, the railway after its long and variegated journey from Rangoon comes to its journey's end. North, east and north-west of Myitkyina civilization is left behind and a tremendous tangle of thinly populated jungle-clad hills stretch away to the borders of China, Thibet and Assam. Some of the curses of modern civilization have recently been brought to these hills and the aeroplane is now a common sight to the wild Kachin who is no doubt also familiar with the sound of mortars and the rattle of machine guns. There must be many Kachins who have flown in an aeroplane before they had ever seen a train, steamship or motor car. Let us hope that it will not be long before this country is able to return to the more or less even tenor of its pre-war ways.

It is not of Myitkyina itself that I wish to write but of the country beyond to which Myitkyina is the stepping-off place, the country that lies to the north-east of it and extends away to the China frontier (*vide map in plate I*). It is country which has been made familiar to many people through the writings of Kingdon Ward and Farrer who have lived for months on end in this back of beyond collecting plants with which to grace the gardens of England. It is a country in which plant life runs riot. Years ago I had read their books and had been seized by the desire to see these hills. There seemed to be romance lurking there with strange animals and birds and a wealth of only partly explored plant life. I wanted to shoot a *takin* and I wanted to see the famous rhododendron forests.

Few Europeans visit these hills; Frontier force officers tour therein, an occasional missionary, the Public Works Department official visiting his roads and bungalows up to Hpimaw, and now and again a plant collector or traveller.

No forest division extends into this wild country and, so far as I am aware, only about two forest officers have gone into the hills and then, I believe, only up the main road as far as Htawgaw. I had almost forgotten one who should be mentioned. He was a Forest Ranger, a Karen from Lower Burma. He had been sent up to collect specimens of *Primula sonchifolia* to be sent home for the late King George the Fifth. He got them all right. Years after I had the chance of reading the diary of his tour and it was very interesting. Coming as he did from the steamy heat of Lower Burma he was not familiar with snow. To get his primula he had to go up 10,000—12,000 ft. where there was an abundance of it. His reactions were amusing. He made and apparently relished ice-cream at that height. He wrote in his diary: "You can have as much ice-cream up here on the Chimili (12,000—13,000 ft.) for a cost of five or six annas as you can get in the Savoy Cafe in Maymyo for three rupees." Well, everyone to his taste!

My chance came in 1938 and in March of that year I found myself in Myitkyina prepared to start off on a two months trip. I

was accompanied by an Army officer with a taste for exploring and painting who had taken two months leave and turned his back on the flesh pots of Maymyo in the hot weather. On a Sunday in March he sat enjoying his cold beer in the delightful surroundings of the Maymyo Club. On the following Sunday, much to his surprise, he was sitting out on a green lawn again drinking beer. But there was no Club. There were two houses and a small fort perched nearly 5,000 ft. up and looking down on the N'mai river. The lawn occupied practically the entire width of the spur on which this little colony lived and was about the size of a tennis court. He had marched for five days to get there.

In Myitkyina there was all the usual fuss of getting off. Twenty-five little Chinese mules were waiting at Waingmaw, a small village several miles down the Irrawaddy on the opposite side. Loads had to be made up into suitable size packages which could be conveniently put onto the mules. Then when ready the kit had all to be got over to where the mules were. The mules were to start ahead of us and do the first thirty odd miles in three stages. We would catch them up at Seniku as it was possible to get a car out to there. Once the kit was off I had two days of peace in Myitkyina. On the third, the day of departure, my companion arrived by the early morning train and at about 11-00 a.m. the journey started. We got safely across the river with a couple of servants and what necessary kit had been kept behind. Arrived at Waingmaw we piled into two elderly decrepit taxis and after rattling along for several hours with only a few minor stops we came to Seniku from where the rest of our travels were to be on foot. Here we found that the mules had arrived safely with all the kit and everything had gone well. The Chinese mules are tiny little animals about the size of a Shetland pony but they are tough. They can carry a load of 120 pounds day after day at a rate of three miles per hour. They get little looking after being turned loose to graze when they arrive in camp. They get a small ration of paddy. Their hides are scarred with old saddle sores and little or no attention is given to raw ones. Each Chinese muleteer has five animals in his charge. On the road they encourage the animals with weird noises.

At Seniku the Public Works Department bungalow at the end of the motor road is perched on a hill top and commands a magnificent view looking north-east up the N'mai valley. From the bungalow the mule road along which we were to travel drops down into the valley of the N'mai *kha**. The N'mai is a broad river full of big boulders and rapids and generally unfordable throughout most of its length. It joins the Mali *kha*, another large river, at the Confluence some distance north of Myitkyina and from there the combined rivers flow south as the Irrawaddy.

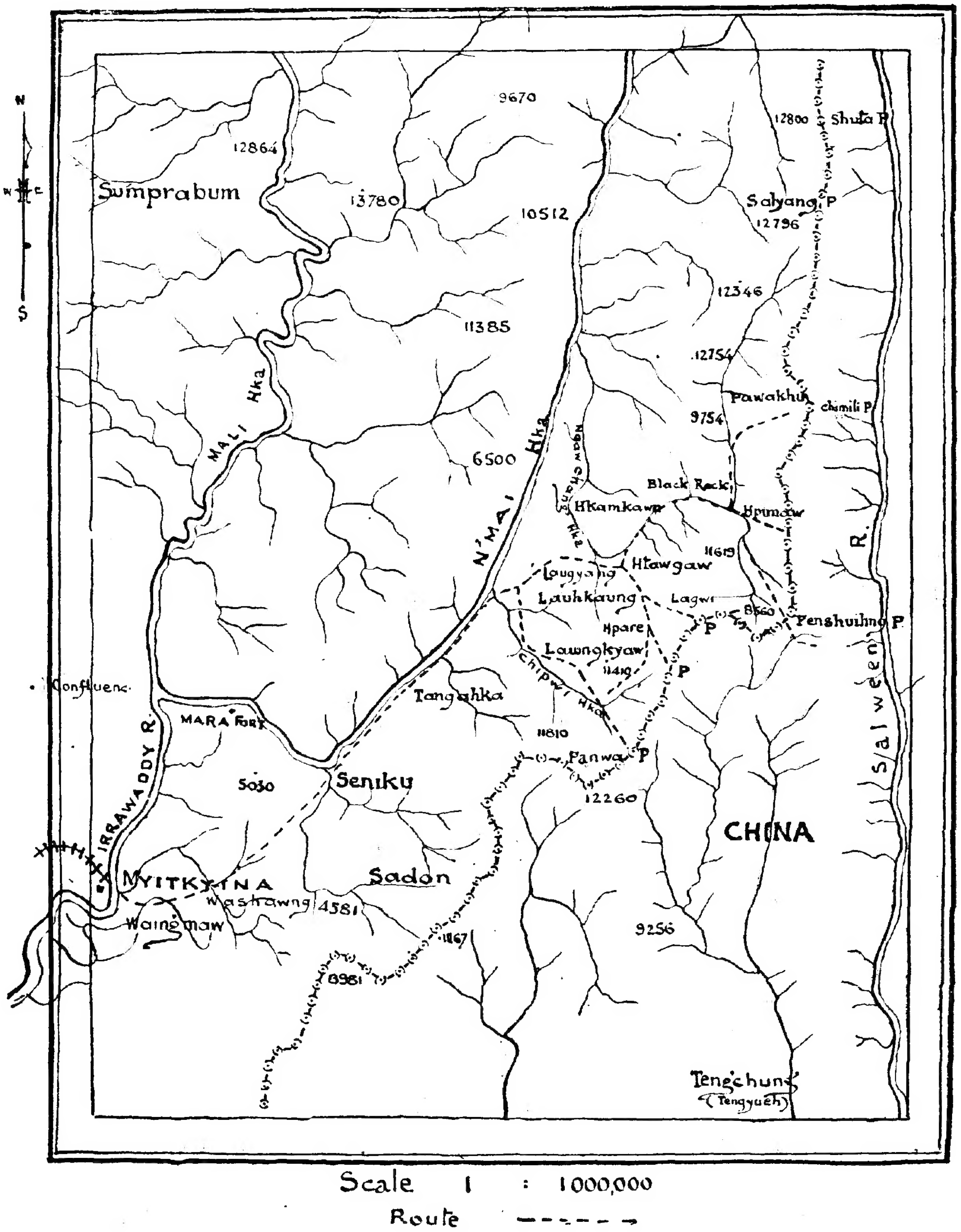
On the next day the journey started in earnest. From now on it was to be all on our flat feet or occasionally on the back of a riding mule of which we had a couple. These were troublesome animals. If separated from the caravan they could only be induced to go at a slow walk unless they happened to be not far behind the main body in which case they would make efforts to join the others and if not hard held would break into an uncomfortable trot.

Having descended the hill we crossed a tributary of the N'mai and then gradually approached the main river. Here, while still surrounded by tropical jungle, we found a rhododendron strayed down from the hills. It was a twiggy shrub, 4—6 ft. high, covered with a mass of salmon pink flowers. It was only found on the rocky banks of the streams and all the way along the valley of the N'mai it could be spotted from a distance as a red blotch of colour on the edge of the white sand or shingle. Here, in March, it was flowering at 500 ft.; later it was found in flower at 5,000 ft.

The first four marches of from 12—15 miles each, lay in the valley of the N'mai and, except where the banks came in steeply to the river, the road ran along near to it. Nothing

***Kha**-river.

BURMA
Part of North-East Frontier



Scale 1 : 1000,000

Route - - - - - →

of very great interest was to be seen, the forest was chiefly tropical evergreen and had been a good deal cut over by shifting cultivation. A very tall wild banana was common in the re-growth and bamboos were much in evidence in such places.

Gmelina was a very common tree near the road on the first few marches and a very handsome *Bauhinia,* completely covered with large butterfly-like flowers, varying from white to fairly deep pink, was found here and there. Later on at somewhat higher elevations this *Bauhinia* was very common and the flowering tops of it could be easily spotted dotting distant hill sides.

All the way up on this road are excellent Public Works Department bungalows. In the bungalow books are recorded notes made by fishermen, for the N'mai is noted for its mighty mahseer. One entry recorded a fish of 90 lbs. Although it was late March, the temperature in this valley had not risen too high and the marches were warm but pleasant. Every evening blowing down from the north came a delightful cool wind bearing with it a breath from the snows of the high hills for which we were heading.

Four days marching and we got to Chipwi, a bungalow with a village in the neighbourhood lying at the foot of a hill up which we proposed to go. For here we were going to bid farewell to the N'mai and make for one of its large feeders the Ngawchang *kha*. Now the Ngawchang forms a wide U, first it flows south, then west, it then turns north and after a flow of some 25 miles in this direction it joins the N'mai. So by dint of hill climbing some short cutting can be done. The fifth march then was a heavy pull-up of about nine miles to Laukkaung from about 500 ft. to something about 4,500 ft. Here is a little outpost of civilization with two lone Europeans, one the Sub-divisional officer and the other the Officer Commanding the Frontier Force stationed here. There is a little parade ground sliced off the top of a spur and higher up the spur the two houses of the Europeans. There is a Public Works Department bungalow, telegraph office and a small collection of houses scattered over the hillside forming a bit of a village.

The Sub-divisional officer put us both up in his little house and advised us to stay a day. This we were only too glad to do both to give ourselves, not yet fully hardened to marching, and the mules a rest and also to discuss and decide on what our route was to be from here. Not knowing much about the country and having used Cox's *Farrer's Last Journey* as my text-book my first idea had been to head straight for Hpimaw six marches further on and at 8,000 ft. with nearby peaks of 12,000—13,000 ft. But the Sub-divisional officer suggested a more roundabout way. We ought, he said, to visit the Panwa pass at the head of the Chipwi valley at a height of about 6,000 ft. Near the pass he said primulas were to be found in abundance and as one of the objects of the trip was to look for primulas we decided we ought to go. This meant going east instead of north and we would gradually work round to our ultimate goal of Hpimaw and take about a fortnight's marching plus a few extra days for an occasional halt.

In addition to the Panwa pass we got a list of other passes that we ought to visit, the Hpare, the Lagwi and the Fengshuiling. Not to be forgotten were the two highest, the Hpimaw and the Chimili, these being the two that we had really come out to see. The roundabout itinerary was to take us off the main road and onto side roads and here there would be no comfortable Public Works Department bungalows with everything laid on. On these side roads at suitable intervals would be thatched shacks built for touring officers. These contained two dark little bed rooms with a central dining-cum-drawing room. In the latter was a fireplace. The designs of these fireplaces, I feel sure, could never have been passed by a Public Works Department officer. They consisted of a square or rectangle lined with stones and earth in the middle of the floor. The floor was usually raised a couple of feet or so off the ground. It might be of bamboo in bungalows at the lower elevations, in the higher it was of large roughly-hewn slabs of wood. There was no outlet for smoke,

It was more comfortable to have a fire made out in the open and sit round that but occasionally rain drove us in to get well pickled with wood smoke inside.

After our day's rest we set off for the Panwa pass some forty-five miles away at the top of the Chipwi valley on the edge of China. The first two marches were uneventful, nine miles each. Little to excite interest was seen as we were still only at the 4,000—5,000 ft. levels and rhododendrons had not begun to appear. The third march, which was to take us into the Chipwi valley, was a memorable one. A real stinker of some fifteen miles which involved a climb up to between eight and nine thousand feet and then a final drop down to the open Chipwi valley at about 6,000 ft. On this march the first signs of a very different type of vegetation began to appear, a few outliers of the great battalions of rhododendrons of the higher hills, a magnolia and two magnificent cherries, large forest trees, in full bloom. Then, on the last lap, we came out of the fairly dense forest to the open country of the Chipwi. Before reaching the open grassland with cultivation and a few scattered groves of oak and rhododendrons the path led us down a forested slope which had been cut over for *taungya*. Here young poplars, just coming out into new bronze and green foliage, were clothing the slopes with here and there a tree of a red cherry in flower. Here and there a peach tree blossomed near the road grown, no doubt, from a stone dropped by some traveller. Then there was the first tree of what seemed to be a magnolia but turned out to be *Michelia doltsopa* in full flower. It is a medium-sized tree with smallish dark-green glossy leaves and this particular specimen was decked out with a covering of cream-coloured, fragrant, waxy flowers about the size of a tulip. The mules and kit did not get into camp until 5 p.m. both they and the servants being pretty well done. We arrived about the same time in no better shape having loitered on the way collecting specimens.

The valley was a pleasant place. The first shack was at the end of the long march in, then there was another about 6 miles on to which we moved after a day's rest. Near this one was a small Lashi village getting their ground ready for cultivation for potatoes. The actual Panwa pass was a few miles on and we walked out to it the day after our arrival. This walk was mainly through fairly open country in a wide valley. Guarding the valley on north and south in the distance were high ridges with the peaks mantled in snow. Near the pass was open park-like grassland still mainly brown after its winter sleep. Abundantly scattered over these open slopes was a lavender primula with its flowers tightly clustered in a ball at the top of a stalk a foot high. This was *Primula limnoica*. The Subdivisional officer was right when he said there were masses of primulas here but unfortunately they were all of one species. Later a few plants of *P. helodoxa* just coming into bud were discovered in a marsh a short distance from our shack.

From the pass you can gaze down into China far below and, in the hazy blue distance, discern what seem to be paddy fields. There is a lot of water about down there. Just below rises a river which, after flowing many miles through China, enters Burma and eventually as the Shweli flows into the Irrawaddy south of Katha. Along the lower reaches much teak is floated into the Irrawaddy but there is none of that up here. Here conifers and trees with pleasant homely names like oak, willow, alder and poplar are attendant on the infant stream. Standing on this pass and later on the Hpimaw pass, a much higher one, and looking onto plains thousands of feet below brought into my mind the words of a low version of a well-known song. I do not intend to quote either the version or the original but the one I mean refers to the 'brink of damnation'.

At first we came to the conclusion that here in this valley was the place where a hill station ought to be. A broad open valley, plenty of room for houses, gardens and the Club. We pointed out a site suitable for a golf course and agreed that a polo ground could be made without much trouble. And what a climate. This was Burma and early

April. Down below the hot weather would be fairly in and even in Maymyo it would be hottish now. Here were cool days and chilly nights. The water in the little river which drained the valley was icy cold and you could look north and south and see snow-covered hills not very far away. Also you did not have dense forest cluttering the whole place up. There were quite enough trees in the valley for æsthetic purposes and, if you really wanted your forest, well, you could climb the hills all round and you'd get all you wanted. But, as usual, there are two sides to every picture and, having counted the blessings, we thought of the other things. It was too close to a part of China which was said then to be full of brigands. There were too many earthquakes; eight or ten mild rumbles could be felt most days; it was very very difficult of access and then, what about the rains? The rainfall here was probably 150 inches and quite likely a lot more and the place would be shrouded in cloud for days on end. Reluctantly we decided that the *cons* were stronger than the *pros*.

I mentioned brigands above. Several times during this tour Chinese merchants came to the camp and asked me to change money for them. They wanted, not notes changed into coin, but the reverse and they were keen to take five and ten rupee notes back with them into China. I asked the reason for this and was told that notes could be much more easily concealed about the person than coin and hence there was less danger of losing them in a wild country where bad men abounded.

Like good tourists we finished our sight-seeing in this valley, ticked off one pass from our list,—one up and five to go—and moved on. The next was the Hpare pass and to get to this involved crossing a ridge about 9,000 ft. high. On this march we really began to find some of the trees and plants of the higher hills. It was on this journey that I first came across that curious rhododendron *R. arizelum* with its huge leaves and tight heads of flowers, each flower reminding me of the flower of a foxglove. I was pleased to get one or two rather indifferent specimens only just coming out into flower. I need not have worried. Later on we were to find miles of *R. arizelum* forest. There is so much of it and it is so nearly pure that I think it ought to be considered as a definite forest type. It is found between the 8,000—10,000 ft. levels. Then there was *R. genestierianum* and here I really thought I had made a new discovery as I argued that no plant collector would take this funny little thing home. But I was wrong. The flowers are not like the flowers of a conventional rhododendron. They are much more open, small and of a deep plum colour with a plum-like bloom on the petals.

Having crossed the ridge the road drops down into the valley and leads on to Hpare. Here there is a little rest house of the usual type situated near a stream. There is a small Kachin village at hand and several of the young women of the village were seen with bunches of rhododendron flowers stuck in their hair. We found this particular species growing just beside the stream. Each head of flowers bore a few great white trumpets.

No mention so far has been made of the local inhabitants. In fact we did not come across them a great deal. Now and again a rest house was situated beside a village but more often the villages seemed to be perched up on the side of some inaccessible hill. We came across members of several different tribes, Marus, Lashis and Yawyins. They seemed to have one thing in common; a liberal coating of dirt. After all, during the winter and spring it can't be much fun to bathe in the icy cold water of the streams in these hills. Presumably the rains is the season for washing. The Yawyins who seemed to be usually at the highest altitude struck me as having the best physique.

After doing the Hpare pass we went up a tributary stream of the valley we were in then over a ridge and so into another small valley. Here we visited the Lagwi pass and I found *sambhar* tracks at 9,000 ft. Near this pass was *Tsuga* forest. On the way up to this pass was a magnificent magnolia *M. campbelli* (I think). It attained the size of a forest tree

and now while leafless was in full flower. The flowers were huge, the size of one's two hands cupped and varied from nearly white though very pale to a deeper pink. Whenever it was possible to get a bird's-eye view of the distant forest it was possible to spot these trees in the distance like the *Bauhinia* of the lower slopes.

This concluded the roundabout and the next part of the journey was to Htawgaw a frontier force fort back on the main mule road. Here was a certain amount of civilization with a good bungalow and a few village shops from which oddments like potatoes and rice could be purchased. Compared to the places we had been in, Htawgaw was a large place with quite a number of houses scattered over the steep hillsides. The Deputy Commissioner, Myitkyina, and the Civil Surgeon arrived to stay for a day; they had been touring and were heading back for Myitkyina.

Two days' halt was enough at Htawgaw. There was little to do and little to collect at that time of the year from the rather bare hillsides. So on the third day we slipped down the hillside into the valley of the Ngawchang and started for Hpimaw. Two long marches up a shut-in valley with the roar of water constantly in the ears and the bungalow of Black Rock was reached. Near here the road forks, one branch going up north before turning off to the Chimili and the other eastwards to Hpimaw. We were going to Hpimaw first and would come back to the northern road later. Near the road junction and for some miles on either side were orchids by the thousands. The old branched oaks supported veritable epiphytic gardens. Species were numerous but outstanding was *Dendrobium nobile* which flaunted masses of its beautiful showy flowers from every boulder and tree trunk.

In this valley, the only place on our tour, we met the blood blister fly, christened for short by us and expressing our feelings towards it, the B-B-fly. This creature is like a small house fly in appearance and where it bites a small blister filled with blood arises.

From Black Rock we marched on to Hpimaw, the road for the last few miles zigzagging steeply up the hill until the ridge top, on which the bungalow is situated at about 7,500 ft., is reached. The village of Hpimaw, a fairly large one, lies surrounded in its little plots of terrace cultivation in the valley about two thousand feet below. Now we were near hills, which for Burma anyway, were really high ones. Near here we expected to see many of the plants mentioned by Kingdon Ward and others and, we hoped, some new ones also. In addition, not far from us in the hills, there were known to be *takin* and possibly as yet unrecorded animals.

Later on, I managed to acquire by purchase from a local villager a beautiful skin of a lesser panda. I asked where these animals were to be found and he pointed north-east to the high snowy hills near the Chimili. He also made mention of an animal with thick white fur which was to be found sometimes up at high levels. The fur of this animal was said to be very valuable in China. Could it be that the greater panda is the animal that was meant? This would not extend its range from its western China home to an incredible extent.

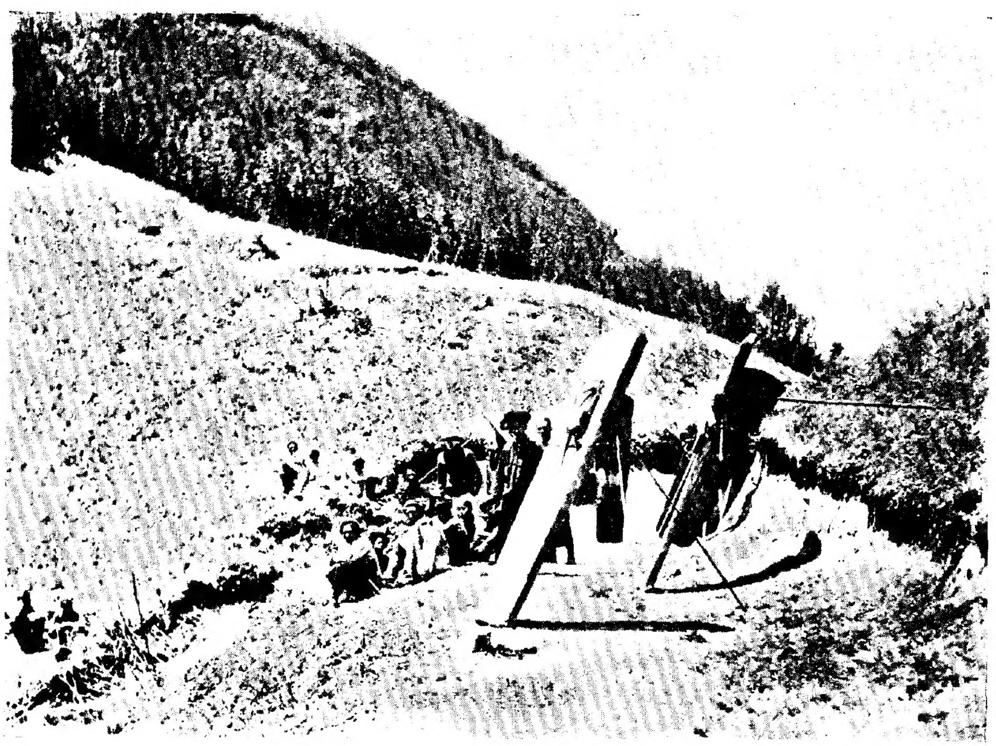
Hpimaw bungalow we made a sort of headquarters and did several trips from it. The first day after arrival, of course, we had to go to the Pass. It was only about five miles away but it was a tough five miles. From the bungalow up past the old fort, deserted and empty now, the road ran eastward to the frontier. Near the fort was a fine old apple tree, monument to some gardening enthusiast, or perhaps come from a casually thrown pip. Whatever its origin, it was a thriving specimen and seemed completely at home in this climate.

Three or four rhododendrons not seen before were put into the bag by the time we had just got clear of the fort. The ascent was partly through forest with *Tsuga* and magnolias and partly through bare brown slopes with the dead remains of last year's bracken and grass. Spring had not touched here yet and some bulbs I dug out from the bank

Fig. I

Primula sonchifolia in flower at 10,000 ft. near Hpimaw Pass.

Fig. II



Export of Coffin Boards by coolie to China *via* the Hpimaw Pass at 10,000 ft. Coffin Boards are probably made from **Taiwania cryptomerioides.**

on the side of the path a bit higher up were in frozen soil. On and on we toiled to the highest point on the road 10,500 ft., then began to drop to the pass which is about 500 feet lower. It is flanked by 12,000 footers. Rounding a bend in the road just before the pass was reached, I had my first sight of *Primula sonchifolia* at home here in all its glory (*vide plate 2, Fig. I*). Apart from trees it was about the only thing that had waked from the winter sleep. And winter had not yet quite gone; small dirty patches of old snow were still lying near the path.

The leaves of the primula were young and only partly developed but their resemblance to those of *Sonchus* from which the plant derives its specific name were unmistakable. The flowers were full out in all their beauty. A coloured picture of this species was published in Curtis' *Botanical Magazine,* Vol. 161, 1938-39. I cannot say whether the colour of the plate truly represents *P. sonchifolia* as it grows in England but it does not represent it as it grows near the Hpimaw pass. I should describe the colour there as a sky blue which had been lightly dusted with powder to take away the vividness of the blue. The centre of the flower has an orange eye. I saw this species at higher altitudes near the Chimili and the plant was smaller and the flowers of a much poorer colour than the Hpimaw ones. As seen in this one spot it fully merits the enthusiastic descriptions of it given by various collectors.

Well, I had now seen one of the things I had come all this way to see and, although I was not exactly prepared to say *nunc dimittis,* I had a feeling that here was something that had not only come up to but had exceeded my expectations.

Having gazed my fill, photographed and collected specimens of the primula I went on the few yards necessary to reach the pass and found my fellow traveller busy at work painting. Here the road crossing the boundary is bordered by brown slopes covered only with dead vegetation but a few yards up from the road is dense growth of bamboo and scattered bushes of rhododendron, one species of which was already in flower. A cold wind was blowing from the Burma side so we moved round the shoulder into a sheltered corner of China and had our lunch. While we were lingering on the pass before returning, a party of Chinese coolies came staggering up the road from Burma each one bowed down with a huge slab of wood on his back. Arrived at the pass, they set the lower edge on the ground and stood the slab partially upright supported on a long stick. They then threw themselves on the ground panting to rest (*vide plate 2 Fig. II*). When they wanted to go on again they walked under the boards let them down on to their shoulders and walked off with them. I had no tape with me but guessed that the slab was about 7 ft. long, 2 ft. 6 in. wide at the top tapering to about 1 ft. 9 in. at the bottom and about 3 in. thick in the thickest part. I could not estimate the weight but as I later saw some being taken on mules and only one was carried by a mule unless it was a mule above the average in size I have made a guess. At a guess then I should say the weight was upwards of 100 lb. No mean weight for a man to carry over a pass of 10,000 ft. height.

These great boards were going down into China to be sold to wealthy Chinese for coffin boards. At one time, it is said, there used to be a big trade in them going over the various passes from Burma into China. The trade has been mentioned by several travellers who have been through these hills. It seems to have slackened off in recent years perhaps because the great trees from which they are hewn are getting scarce and only to be found in inaccessible areas. For a long time it was thought that the tree from which they were cut was a species of Juniper. I was, however, later on able to get specimens of branches of the tree and recognised it as *Taiwania cryptomeriodes.* Kingdon Ward who did an expedition to this area at the end of this year confirmed this identification and wrote a note about it in the *Gardeners Chronicle* in 1939.

Having seen the Hpimaw pass the next excursion was to be to the Fenshuiling. The name fascinated me. It was something

definitely Chinese and unlike any of the place names we had come across so far. To get there meant a two days' journey south from Hpimaw to the last bungalow on the road and then one day's halt there to do a look at the pass. We short cut for the first march and a Kachin short cut can be something fierce. It rained most of the way and we arrived at our new shack wet and rather miserable long before the mules were due. We were able to get a fire going inside and managed to get fairly dry and comfortable.

The pass itself proved disappointing as there was thick forest all round it and no view obtainable. However a number of interesting things were collected. Before getting to the pass some open country was traversed. In this was open spruce forest with a few juniper and bamboo. Spruce and bamboo seems a peculiar mixture. It was the only time on the tour that I came across spruce. One wet section of the path going up was lined with a tall yellow candelabroid primula (*P. helodoxa*) and a marshy meadow just off the road was covered with it. Another section of the road was lined with a big bushy rhododendron covered with flowers. The fallen corollas of this carpeted the road. Not far from the pass was a patch of a peculiar *Arisæma*. The spathe of the inflorescence had the appearance of a cobra with its hood spread. From the tip of the spathe extended a filament 3-4 feet long. The curious thing about this was that it was not trailing on the ground but was caught up on the leaf 2-3 feet above the level of the flower spike. I wondered how on earth it had managed to get there. An inspection of some plants not yet fully out in flower gave the answer. The inflorescence is enclosed within the base of the leaf stalk and the filament develops so that it is held within the blade of the leaf. As the stalk grows up and the blade is carried up into the air and unfolds the tip of the filament goes with it. It would be interesting to know what purpose this appendage serves.

The return to Hpimaw was uneventful. The next trip was to be an expedition after *takin*. This had been laid on before and coolies fixed up as there were no mule roads in the jungle I was going into. I was to do this trip alone and spend two nights out. The other member of the expedition was to stay at Hpimaw and paint. Information was very hard to get. There was said to be a salt spring some miles away to which these animals came occasionally. Estimates of the distance varied from 5—13 miles. If the latter turned out correct I know I was in for a bad day for, from our ridge top, I could see the country I was to go over. Starting with a drop of 2,000 feet down to Hpimaw village there were then the tail ends of two spurs to cross before starting to climb again. Well, it turned out to be nearer 5 than 13 miles and I was in camp before mid-day in evergreen forest. The only place I could find to pitch my tent was a small flattish area by a mountain stream. Most of this patch had been planted up by the local people with a medicinal herb which later on I got identified as *Coptis teeta*. In the afternoon I was to visit the spring which was said to be only about half a mile away to see if there were any signs of *takin*. So after tea I set out and after a most revolting scramble along the banks and in and out of a mountain torrent with very cold water which took well over an hour I got to the place. No sign of *takin* here and tracks showed that it had been some time since the spring was last visited. So home to camp disconsolate and to confer about what to do next. The local *shikar* experts decided that it was no good staying here. The kit and coolies ought to be sent on to a new camp to-morrow, while we ourselves would take a walk round the higher hills and see if we could find anything. So we decided and orders were given accordingly. I had a Burmese collector with me and he was to go off with the kit and collect on the way.

Morning came and we started off according to plan. I have no detailed recollection of that day. Up and up we went until we were in snow and the experts decided that we were higher even than *takin* would be likely to be found. Of the vegetation going up I remember only going through thickets of

raspberries covered with prickles. There was no sign of any life until the first of the snow was met and here four or five large birds were momentarily glimpsed. I got the impression of vivid colouring before they disappeared into the scrub and imagine they must have been tragopans or some other pheasant. Several times I had had on previous occasions glimpses of large pheasant-like birds skulking away into the undergrowth. Two pheasants, one a Stone's and one a Lady Amherst's had been shot earlier on by our Kachin interpreter. Both were birds of gorgeous colouring. Before setting out I had been asked by a keen birdman to collect birds if I could. As there was no skinner in the party I was given a hypodermic syringe and some formalin and instructions how to deal with them. My first attempt was on a little bird that I had shot. This seemed to be fairly successful. The second attempt was on the Stone's pheasant. He was dealt with according to instructions and packed away. A few days later it was reported that all was not well. An inspection was made and it was found that the corpse was stinking to high heaven. It had to be thrown away quickly. We regretted the waste of a good pheasant but not I fear either from the humanitarian or from the collectors' points of view.

I am afraid I have wandered away from my story. When it had been discovered that we had got high enough it was then decided that we should go downhill and take a chukker round the lower slopes (that would be between about the 9,000—10,500 ft. level). A halt was called for lunch before starting on this. I found a sheltered depression and there with patches of snow all round was quite warm in the sunshine although only wearing shorts (plus top garments, of course). The only thing I saw in flower at this height was a *Caltha* growing in wet ground which looked identical with *C. palustris*. After lunch was finished we started off downhill. It was a dreadful scramble. The first part was through bamboo and raspberry jungle (another queer combination). The slope was very steep and I had to cling to bamboos or bushes of small stunted rhododendrons. A slip and you found yourself seated in a patch of snow. Lower down there were only odd patches of snow and here the ground was wet and soggy with inches of decayed vegetation oozing water, then at last down into forest of some sort. I wasn't interested in what sort by this time but it was all very wet and I remember there were many ferns about. Having got to this level we then started contour following and I think this was much worse than the plain up and down as we had to go down into each little mountain torrent, cross it—a wet and slippery process—and then up the opposite side. In one place we did come across some *takin* tracks but they were two or three days old. After what seemed an interminable time climbing down into little ravines and climbing up out of them we at length broke out of the forest and came out onto an open bare patch. There in front of us was the camp just being put up. It was about an hour before dusk so the coolies must have had a good day too. I looked about and across the valley I could see the Hpimaw bungalow on its ridge top. It seemed to be some distance below me so I estimated the camp site as being near to 9,000 feet.

On checking up I found that Po Khant, my Burman collector, was not present. He had apparently gone off collecting on his own. Time went on and as darkness was beginning to draw in I was getting a bit anxious about him. However, just before dark he came in with his collecting tin full. I inspected the contents. The finest specimen, taking up much of the interior of the tin, was a large lump of snow! He had seen the snow-covered hills in the distance on the way up and had been politely acquiescent when I told him that the white tops were due to the covering of snow but evidently had not really believed it. To-day he had gone to see for himself and came back satisfied. In addition to the snow he had a rhododendron that we had not seen before. I myself had also got a rhododendron on the way, a straggly shrub of the understorey with a head of three or four flowers of a deep luminous crimson.

It started to rain later and it was not too pleasant in a small tent on that bare hillside. Fortified with some hot rum and dinner I turned in early and slept the sleep of the tired out only waking for a moment during the night to register the sound of rain on the canvas. Dawn broke fine and after a very steep drop down into the valley into Hpimaw village I once again faced the steep and long climb back to the bungalow. On the way down a barking deer was seen out on an open slope. I missed a long shot at it. This was the only shot I fired from my rifle during the whole trip. The long climb-up to the bungalow was not bad, as I had had the forethought to order one of the riding mules to be brought to meet me at the bottom of the hill.

After a day's rest during which it rained hard we set off for the last of the passes and the highest, the Chimili. Two short marches along the banks of the Ngawchang brought us to Kanfang still in the bottom of the valley. The Ngawchang here is not the noisy river in a gorge that it is lower down. Here the valley is wider and the river smoother flowing. Very attractive it looked too on a bright sunny day the water clear and blue with a white rock standing out here and there and the opposite bank fringed with the salmon pink rhododendron with behind it the green of trees and bushes.

Spanning the river at Kanfang was a Kachin cane bridge. Several were seen on this stretch of the river. Fortunately we had not to use them at any time to cross by. I ventured out a few yards on this one and then retreated not liking it a bit. This particular cane bridge is a bit of a fraud as it is reinforced with a number of strands of telegraph wire.

From Kanfang we turned aside up a feeder of the Ngawchang and climbed up the valley to Pawakhu. A notable find on the way was *Rhododendron megacalyx* with its huge white flowers. At Pawakhu there is a Yawyin village in a small open valley shut in on three sides by snow-covered hills. We halted there for about three days but only on the last evening did the clouds lift to give us a complete view of the circle of hills with their sparkling white crowns. This little valley was still bare and brown.

To get from the village up to the Chimili pass we found that it would be necessary to go into camp at nearly 10,000 feet about five miles from the village and explore from there. But there were snags about this. The mule track was said to be in a bad state of repair—this was found later on to be true enough. Also there was said to be near the camp some poisonous vegetation that would finish the mules off. The only way was to get coolies and move camp with them. As we were running short of time we decided we had not time to collect coolies and move camp up there so that we would make an attempt to get to the Pass and back in one day.

The first two days it was raining in the morning but, on the third, the morning broke clear and we set off. The path led up the valley from the village. Looking up from our shack, the top of the valley seemed to be entirely closed in by high mountains. We found as we got up the valley that it turned almost at right angles and became narrower and steeper. For the first two miles or so the country was open, most of it having been under recent cultivation. Then we passed into evergreen forest climbing all the time. Entering this forest, *R. bullatum* was once again found, this time as an epiphyte just coming into flower. It cannot be considered a very showy species as it has not the big massed flower heads of many rhododendrons. It makes up to some extent by its very attractive leaves and by the very fragrant flowers. Pushing on through the evergreen forest before the higher slopes were reached the striking thing was the abundance of seedlings and young plants of various species of rhododendrons on the banks by the path. They were present in thousands. As the higher slopes were reached the forest thinned out a bit for a time. We were then bending more to the east. At this level the undergrowth was all brown and the ground was littered by dead, decaying growth

of last year. The only find was a small primula *P. euosma* which I believe is not in cultivation. It did not strike me as meriting the enthusiasm that some plant collectors have lavished on it. There were two varieties, a white and a bluish. It was not unlike *P. sonchifolia* in colour but the plant is smaller and there are only a very few flowers in the head. Another primula with a resemblance to *P. sonchifolia* but with only a few flowers in the head was *P. klaveriana*. This seemed to prefer the darkest and wettest places in the forest.

Eventually we reached the spot where we should have camped if it had been possible to do so and now we were approaching conifer forest. It started to drizzle but we pressed on hoping for an improvement. Eventually the first snow was reached and as it was still raining we decided to halt for lunch. It was cold and miserable. A local Yawyin we had with us managed to get a fire going by getting some dry material out of the inside of bamboos to start it with. So we ate our lunch standing over the fire dripping water and turning round at intervals to warm up different sides of the body. It brightened a bit after lunch so we decided to push on. The path was very bad in places especially going round the sides of gullies where the small logs which in places carried it round had fallen away. After some hard scrambling we came to a place where the path seemed to end. Clouds were right down on us and the view was nil and snow was everywhere. Our Yawyin guide scrambled a bit up the hillside and said that it was not possible to go any further because of deep snow. He brought back a tiny little primula (*P. fragilis*) with him, a plant about an inch high with flowers of a size absurdly large for such a little plant.

We were on the point of turning for home when suddenly the cloud lifted and for a few minutes we had a glorious view. There was just time to take a few photographs before the clouds came down and the show was over. We found ourselves on the edge of a steep-sided valley. Below us was forest of wind-swept silver fir with bamboo and rhododendrons, one already in flower in spite of the snow. Across the valley and above our level were slopes stretching out to the frontier bare of vegetation but dazzlingly covered with deep snow. It was not possible to say how far we were from the pass but it could have been no great distance. We had been unlucky in either coming too early in the season, or, because the snow had lain later than usual. The only consolation was, that with all that snow covering everything, there was nothing to collect so that nothing had been missed. I regretted it because it was the only chance that we might have had of getting into the lower levels of the real alpine flora. Except on the one occasion when I had been out after *takin* I had not got above tree level and even on that day I had not got above the level of bamboo. Incidentally that bamboo is very deceptive. Seen from a long way off the hills seem to be covered with forest up to a certain level then above that grassland. It is only when you get up to this "grassland" that you find it is dense thickets of a small bamboo 10—15 ft. high.

While in this camp at Pawakhu I had sent a man scouting round the hills to look for signs of *takin* but with no results. We could not afford to stay any longer. My companion's leave was nearly up and I was also due back. Off we started then on the return trip following the same route as we came as far as Htawgaw. At Black Rock we collected about a couple of mule loads of orchids for the Maymyo gardens. At Htawgaw we halted for a day to rest the mules. The weather had been steadily worsening and on the day we were due to leave Htawgaw we woke to find the rain pouring down. We had trouble with the mule-men here complaining about the weight of the kit and it was certainly true that the tents which were well soaked by now were much heavier. Loads therefore had to be readjusted. Later in the day it cleared up and we moved off in the direction of Laukkang. This part of the way was new to us as we had missed the direct route on account of our tour of the lower passes.

There was nothing of interest to record on the three marches to Laukkang except on one of them when leeches were encountered for the only time on the trip. On this march I was following at some little distance behind the mules when I noticed that the path was spattered with blood. I looked more closely at it and then noticed that the place was full of leeches. Battalions of them were looping towards me. I hurried on and when I got up to the mules found that they had anklets of leeches above their hooves and masses of them on their nostrils as well. It didn't seem to worry them. A Chinese mule has worse to put up with than a few leeches.

At Laukkang we met our old friends the S.D.O. and the Commandant and regaled them with stories of our travels.

Then came the melancholy business of leaving the hills. From Laukkang down to plains level was only one march. I set off alone, my fellow traveller lingering behind for an hour or two. I took the Kachin short cut down to Chipwi which was about six miles instead of the nine miles by the mule road. I forgot to mention before that over the Chipwi river, forty or fifty feet above it, was a fine suspension bridge capable of taking mule traffic. I approached this bridge. The entrance is flanked by two stone pillars. I passed the pillars and stepped on to the bridge. Then I drew back in dismay. The railings guarding the sides were not there, worse the decking had disappeared. All that was left was the skeleton of a bridge. The Public Works Department were busy carrying out repairs. A temporary bamboo bridge which was to carry traffic while the suspension bridge was under repair barely reached half way across the stream. What was to be done? I could not face the walk over that skeleton but I could swim the river. But what about the mules? I searched up and down the stream but could find nowhere where they could cross. Then the mules began to arrive and the mulemen decided how it was to be done. They got hold of a number of decking planks and laid them length-ways along the bridge. I could not face that narrow path in mid-air so decided to have my swim and bathe. I lay in the middle of the river in a calm spot clinging to part of the new bridge and watched with apprehension the mules going over, every moment expecting one of them to come hurtling down to join me in the river. However, they all got over safely. Then just as I was about to leave the river I spotted my companion coming down the opposite hill. I decided to wait and see what would happen. Down he came, briskly approached the bridge and boldly stepped past the pillars. Then a hesitation, a look round and a sudden withdrawal. I felt stupidly pleased that I was not the only weak vessel and shouted to him to tell him where to swim across.

Down here in the valley we were back in the hot weather and marches were not pleasant. In addition to heat we were getting a lot of rain. In fact the descent to Chipwi was the first fine march we had had for some days.

All the way down to Seniku we had a good deal of rain. At Seniku a taxi had been arranged to take my companion in to Waingmaw and Myitkyina. I was going to march the last three stages to Waingmaw with the kit. Arrived at Seniku there was no sign of a taxi and as time went on we began to get a bit anxious as his leave was very nearly up. With the taxi I expected my camp clerk with letters and more important, some beer. We had taken none of this with us on account of transport difficulties and after the four hot marches down the N'mai valley we were looking forward to a bottle of it.

The taxi turned up in the end with camp clerk and peon but no beer. A long and circumstantial story was produced by the clerk telling how he had been robbed on the train coming up to Myitkyina the night before and all the beer had been stolen. The bleary eyes of both he and the peon robbed the narrative of any trace of verisimilitude it had but there was nothing that could be done about it.

I did three hot and very wet marches down to Waingmaw and arrived to find the Irrawaddy coming down bank-high in a brown

swirling flood. Having crossed the river I was again in an outpost of civilization, Myitkyina, and from there back to Maymyo was nothing more adventurous than a train journey.

I ended the trip with a great desire, the desire to do it again, to go a bit farther afield the next time, to take four months or more over it and move round more leisurely. I still have that desire and still want to shoot a *takin*. But time passes all too rapidly and by the time that Burma is once again a peaceful country and it is safe to travel through these hills it may be too late. Too late because it is a strenuous trip if one is going to leave the mule roads and adventure up the hills, and though the spirit may still be found willing the flesh may be too bulky.

THE ROLE OF LEAF FODDER IN ANIMAL HUSBANDRY OF THE UNITED PROVINCES

By M. D. Chaturvedi, I.F.S.

Summary.—During the cold weather when grasses become inedible, leaf fodder supplements the food resources of 5 out of 39 million domestic animals in the United Provinces. Introduction of leaf fodder species in the plantations both in the reserved and private forests, afforestation of wastelands and effective control of lopping will go a long way towards the development of this important source of food supply of the livestock in these provinces.

Domestic animals play an important rôle in the rural economy of the United Provinces. The bullock and the buffalo constitute the mainstay of agriculture which sustains the bulk of the population living in about 100,000 villages dotted over the length and breadth of these provinces which have an area of about 106,000 sq. miles. Tractors and other mechanical contrivances are beyond the ken and reach of the average cultivator who ekes out a living with his age-long plough and bullocks. Transport along rough and ready inter-village communications is still chiefly dependent on animal traction in which bullocks, buffaloes, horses, mules, donkeys and camels play their humble part. The cow and buffalo, the sheep and goat apart from yielding milk and other dairy products, provide also meat for human consumption.

Domestic animals subsist on concentrates and roughage. The roughage is derived from grasses, weeds growing on cultivated lands, cultivated plants, stubble of crops, chaff, and leaf fodder. During the four monsoon months (June 15 to October 15) grasses grow plentifully, vigorously and ubiquitously. During the rains the grasses are luscious, have high nutrient value and maintain the entire livestock in good condition. The cold weather (October to February) in the Gangetic Plain is characterised by intense cold, occasional frosts and limited precipitation. Conditions such as these are hardly suited to the growth of grass which is arrested with the cessation of the monsoons. As the cold weather advances, grasses progressively turn tough, inedible and consequently unavailable as food. Indian conditions and tradition are not conducive to the storage of grass in the shape of hay or silage. By the time the hot weather sets in, *i.e.* by March, the vast majority of pasture lands in the plains begin to get practically bereft of all vegetation and continue a desolate and parched existence unrelieved throughout the heat of the summer. The cattle wander far and wide in search of food and eke out a miserable existence. The break of the monsoon (middle of June) turns the sun-scorched grazing grounds into green pasture lands which secure a fresh lease of life to skeletons euphemistically described as live (!) stock.

It will be seen that for 8 months in the year, domestic animals must depend for their existence on progressively diminishing supplies of grasses, by-products of agriculture and green fodder crops, the cultivation of which

is limited by the scarcity of land allotted for the purpose. All available sources of fodder are tapped. Dry cattle emigrate to the accessible grazing grounds in the *tarai* where moist conditions are conducive to the growth of excellent fodder grasses which sprout in spring after a good burn and are available throughout the summer. During the cold weather leaf fodder, wherever available, constitutes an additional means of subsistence for livestock. It is customary, therefore, to correlate the livestock in these provinces not with the precarious grazing available in pasture lands, but with the total area under cultivation which carries almost the entire burden of supporting it for eight months in the year.

A passing reference to the 1944 return of the livestock of these provinces will afford an idea of the baffling nature of its feeding problem. The figures, given below, cover the entire area of the United Provinces, except the hill districts of Almora and Garhwal.

1.	Cattle (cows, bulls, bullocks)	21,098,240
2.	Buffaloes	8,523,243
3.	Sheep	1,873,873
4.	Goats	5,472,942
5.	Horses and ponies ...	380,744
6.	Mules	16,996
7.	Donkeys	221,916
8.	Camels	31,221
9.	Pigs	1,226,853
	Total ...	38,846,058

or 370 head of cattle per sq. mile approximately.

Of these 39 million domestic animals not more than 1.5 million have access to the reserved State forest where the bulk of leaf fodder is available. In the absence of any accurate information one might hazard a guess that about 4.5 million domestic animals graze in private forests and scrub jungles. Thus, not more than 6 millions out of a total population of 39 millions of domestic animals (or 15 per cent) have access to grazing areas with tree growth on it.

The total area under tree growth in the plains amounts to approximately as under:—

	Million acres.
State reserved forests ...	2.86
Private forests and scrub ...	.6
Fruit orchards	.5
Roadside trees and odd trees dotted here and there ...	.54
Total ...	4.50

or about 7 per cent of the total plains area. While unrestricted lopping for leaf fodder takes place during the cold weather in most private forests, scrub jungles and roadside avenues, the Forest Department exercises a strict control on lopping in the reserved forests and admits only a limited number of domestic animals to areas specially set apart for the purpose. As a rough estimate not more than 0.5 million of livestock is dependent on leaf fodder in the reserved forests. The total leaf fodder incidence on areas with tree growth in the plains would roughly amount to:—

Reserved forests ...	0.5 million
Others ...	4.5 millions
or	5 millions

Thus about 12 per cent of the total livestock in these provinces is dependent for supplementing its food on leaf fodder for about five months in the year (November to March). With the advent of spring most leaf fodder trees put on fresh leaves which being toxic are unfit for cattle consumption.

The management of miscellaneous forests for a sustained supply of leaf fodder in the Saharanpur Forest Division is typical of action taken, or which should be taken, in most other similar forests in these provinces. The basic principle underlying the lopping of trees for fodder is to ensure periodic closure in order to provide the necessary respite for trees to recover from damage caused. Although trees

lopped during the cold weather usually recover at the end of a single growing season, a rest of three growing seasons secures complete immunity to any likely damage to the growth of trees. Experience gained in the Saharanpur Division, where rotational lopping has been in force for the last 13 years, points to the reduction of the rest period from three to two growing seasons. Other features of lopping schemes worthy of note here are.

(1) Certain valuable species are declared as 'protected' and are not permitted to be lopped.

(2) The liability of certain areas to erosion, land slides and slips demands careful nurturing of all vegetation and lopping is, therefore, out of question in such areas.

(3) Saplings and small poles are not permitted to be lopped.

(4) The upper one-third of the crown of all trees is protected from lopping. Lopping of branches below two or three inches in diameter in the lower two-thirds of the crown is also not permitted.

In private forests, scrub jungles and other areas with tree growth, no attempt has hitherto been made to control lopping. Unrestricted lopping has progressively reduced leaf fodder resources by arresting the growth of trees.

The demand for leaf fodder has in comparatively recent years determined the choice of species in most of our *taungya* plantations in reserved forests, where fodder species have been freely introduced.

Mention may also be made here of the rôle which leaf fodder plays in the upkeep of livestock in the hills, where the precipitous nature of the country limits the land fit for food production and where grazing grounds are few and far between. Cultivation of fodder crops is practically unknown due to the scarcity of land, and livestock has to depend very largely upon grasses, leaf fodder, and by-products of agriculture. Without leaf fodder, animal husbandry would be out of question and its importance in the hills could scarcely be overemphasized. The management of forests in the hills, more particularly the control of lopping, led to a widespread agitation in the past culminating in the appointment of a Forest Grievance Committee which reviewed the entire forest administration in the Kumaun in 1921. Forests in the hills were thereafter managed in accordance with the recommendations of the Grievance Committee. Vast tracks of oak forests over which liberal concessions had been granted had been lopped to death by 1939 when the position was again examined resulting in a stricter control of lopping which is now the order of the day. In their briefest outline the general principles underlying the control of lopping in the hills are the same as those in the plains. Certain species are completely protected as royal trees everywhere while others are protected only in specified localities and some are open to lopping without restriction. The question of rest period has not hitherto drawn the attention it deserves in the hills. To ensure a continuity of management in the interest of the commonweal it seems desirable to enlist the sympathy of the villagers affected through their own corporate bodies, such as *panchayats*, co-operative or better living societies.

The species which yield suitable leaf fodder in these provinces have already been included in the Forest Research Institute publication *Fodder trees in India** and no useful purpose will be served by reproducing them here.

Mention may be made here of an investigation on the nutritive values of certain leaf fodder carried out at the instance of the Forest Department, U.P., by the Animal Nutrition Section of the Imperial Veterinary Research

* M. V. Laurie, 1939.

Institute at Izatnagar. An analysis of samples of green leaves of *Adina cordifolia, Bauhinia variegata* and *Morus alba* gave the following nutrient contents:

Species.	PERCENTAGE COMPOSITION ON DRY BASIS×100.							
	Ash		Crude protein.	Fibre	Nitrogen free extractive	Crude fat	Lime (CaO)	Phosphates (P_2O_5)
	Total	soluble						
Adina cordifolia ..	793	752	1,526	1,269	6,019	393	241	26
Bauhinia variegata ..	854	793	1,315	2,937	4,682	212	340	42
Morus alba ..	1,380	780	1,399	1,571	4,970	680	274	45
Average of 5 typical U. P. grasses ..	1,065	293	453	4,556	4,818	109	53	49

It will be seen that compared with grasses, leaf fodders of the above species are exceptionally rich in such essential nutrients as crude proteins, nitrogen free extractives, crude fats and lime. The absence of data pertaining to the digestive trials of these leaf fodders renders generalisation regarding their comparatively high nutritive value difficult. It may, however, be stated that the nutrient contents of these leaf fodders compare favourably with young lush grasses and green leguminous forages noted for their nutritive value.

During comparatively recent years the creation of fuel and fodder reserves on village lands has specially engaged the attention of the Government of these provinces and forest extension schemes have been launched by the Forest Department in collaboration with the Rural Development Department. To date, 1,312 plantations covering an area of 5,732 acres have been made and work has been concentrated in the main in the north-western part of these provinces. Small as these plantations are, their real value lies in the demonstration they provide of the possibilities of afforesting vast unculturable lands lying unproductive in these provinces. The introduction of fodder species in these fuel and fodder reserves will go a long way to provide the necessary relief to cattle in the shape of leaf fodder. The land available for this purpose has been estimated to be about eight or nine million acres or about twice the total area of the land under tree growth in the plains of these provinces. Proposals regarding the creation of a Land Utilization Department to handle this as well as other projects are well under way and figure prominently in the post-war reconstruction schemes which are receiving the attention of Government.

GERMINATION OF PROSOPIS JULIFLORA

By A. L. Griffith

(Central Silviculturist, Forest Research Institute)

In the past two or three years the regeneration and afforestation of dry areas has been receiving increasing attention and two of the most important species considered are *Prosopis juliflora* and *P. glandulosa.*

Recently, retports of difficulty of germinating the seed of these species have been coming in from places widely separated in distance and from officers entirely unconnected with each other. The common factor in these reports is that they all come from very arid areas.

For ten years or so Madras has been using this species in dry fuel forest regeneration work and germination difficulties have not arisen. The seed used in Madras came from the Punjab. (*Vide: Silvicultural Research in the Madras Presidency* of the past few years).

Mohan (1940) refers to slow germination and to insect attack on the seed but does not record any difficulty of germination (*Punjab Forest Records,* Vol. I, No. 9, *The Mesquite*).

In order to gather further information the silviculturist, Punjab, supplied us with seed of all the varieties of the species available in August last year. This was very late in the season and hence conditions for germination were not good.

The seed was examined for soundness and weighed both in the pod and as separated seed. Germination tests were carried out in pots, in boxes and in nursery beds. With each variety presowing treatment of soaking the seed in cold water for 24 hours (as recommended by Mohan) was tried.

Results are given in the table below:

Species.	Variety.	Pods per oz.	Seeds per oz. with pulp.	Soundness percentage.	Germination %		Period of germination in days.
					Control.	Treated.	
P. juliflora ..	Texas ..	12	210	68	23	21	5 to 61
	Valutine ..	..	279	..	12	13	5 to 61
	Mexican ..	10	334	74	18	15	8 to 60
	Nigerian ..	12	226	74	43	47	4 to 60
	Peruvian ..	10	260	64	14	17	7 to 60
	Arid ..	9	358	46	8	12	5 to 59
	Mexican special ..	6	184	90	13	14	5 to 58
	Argentine ..	7	223	56	25	48	5 to 58
	Australian ..	9	414	74	41	39	5 to 58
P. glandulosa ..	Tree form ..	6	260	84	11	10	7 to 60
	Shrub form ..	..	467	63	28	24	6 to 59

It is seen from these results that all the seed was seriously insect attacked, some of it to the extent of 54 per cent. In spite of this, germination of 10 to 50 per cent was obtained in 5 to 60 days. (It should be noted that random samples of the seed were sown and no separation of insect attacked seed was done).

It therefore appears that there is nothing wrong with the seed itself and we must look for other causes of the reported difficulty in obtaining germination.

It is possible that insect attack in the seed used has been much more widespread than has been realised. It is also possible that the seed reacts to differences in climate more than has been suspected.

The above therefore emphasises once again the necessity for carefully examining and testing all seed before sowing.

The Silviculturist will be grateful if forest officers with recent experience of this seed will send in all the information they have. It is a subject of great importance and is to be discussed in the coming silvicultural conference this year (1945).

Method of sowing and presowing treatment of Prosopis juliflora.

A further experiment was done with seed of the Australian variety. Three presowing treatments were used, (*A*) seed immersed in boiling water and allowed to cool, (*B*) seed soaked in cold water for 24 hours and (*C*) untreated control. In each of these treatments three methods of sowing were used (*i*) $\frac{1}{4}$ in. length of pods, (*ii*) 1 inch length of pods and (*iii*) cleaned seed with pulp separated from pods. Results of germination per cent were as follows:

	Boiling water.	Cold water.	Untreated control.
$\frac{1}{4}$ in. pods ...	5	8	9
1 in. pods ...	4	9	6
Cleaned seeds	2	11	13

No separation of insect attacked seed was made before sowing.

Presowing treatment of Prosopis glandulosa.

Seed received from Hyderabad (Sind) and which had been stored for 11 months was tested by sowing in a nursery bed after applying three treatments (A) seed immersed in boiling water and allowed to cool (B) seed soaked in cold water for 24 hours and (C) untreated control.

Results were as follows:

Treatment.	Germination percentage.	Plant. percentage.
Boiling water ...	50	43
Cold water ...	34	30
Untreated control ...	57	53

The work thus gives the following tentative indications: —

(1) Seed of *P. juliflora* and *P. glandulosa* is very liable to insect attack and should, therefore, be thoroughly inspected and carefully stored before use.

(2) The seed itself is capable of a high percentage of germination.

(3) Treating with boiling water before sowing is definitely harmful.

(4) Treatment with cold water before sowing results in general in a slightly higher germination per cent. It also results in quicker germination. It should be noted that under very dry conditions presowing treatment of seed is to be avoided if possible as it is dangerous to force the seed to germinate at a definite time which may be unfavourable climatically.

(5) Extracting and cleaning the seed before sowing gives better germination and it is for local officers to decide whether this extra expense is worth while.

Note on insects in seeds of P. juliflora (Mesquite) by the Forest Entomologist, F.R.I.

Mesquite seed is attacked by at least three species of Bruchidæ of which *Pachymerus gonagra* F. appears to be far the most important. *P. gonagra* is widespread and attacks seed of many species of Leguminosæ. The samples of mesquite pods of Australian origin

sent from the Punjab for examination are attacked by this species.

Most Bruchids are stated to lay their eggs on young pods, the larvæ hatching and boring through to the seeds. If this happens in *P. gonagra*, and it is not definitely stated, there would probably be no great advantage in early picking of pods. Forest Officers might be able to clear up this interesting and perhaps important point.

This Bruchid breeds readily in stored seed for many successive generations and beetles emerge in all months of the year.

Control.—Drying the seed followed by fumigation with carbon bisulphide or hydrocyanic acid prior to storage has been recommended. Both poisons are dangerous and require careful handling.

I rather think that treatment with paradichlorbenzene or perhaps with napthalene may prove the simplest. Both are crystalline and harmless to man. It would be well to make preliminary tests to determine their efficiency and their effect, if any, on germination.

Storage with dry air-slaked lime (1 lb. to each 4 lbs. of seed) is stated to prevent attack (Metcalf). Storage in bins with a two-inch layer of sand on top is stated to prevent entry of beetles: if present in seed they pass through the sand on the outward journey only. (See also Beeson 1941, *Forest Insects* p. 894, based on information from Mysore). Other variations are discussed by Pruthi and Singh 1943, *I. C. A. R. Misc. Bull.* 57.

PATHOLOGICAL NOTES: No. 2†

WILT AND DIEBACK OF *SHISHAM, BABUL* AND *KHAIR* IN THE ARTIFICIAL REGENERATION UNDER AGRICULTURE-CUM-FORESTRY MANAGEMENT

BY K. D. BAGHCEE

(*F. R. I., Dehra Dun*)

During a short 5 days' tour to inspect the irrigated *babul* (*Acacia arabica*) plantations of Lower Sind where this species is being artificially cultured along with cotton, wheat and *bajra*, the writer was struck with the repetition of the pathological phenomena occurring in the same sequence as noted previously in the case of *shisham* (*Dalbergia sissoo*) in Punjab, and *babul* (*Acacia arabica*) and *khair* (*Acacia catechu*) in the *taungyas* of the U. P. *terai*. This mortality of *babul* in a virgin area where in the absence of forests, each single tree is an asset in itself, has again brought into prominence the questionable future of the *Leguminous* species in the artificial regenerations under the agriculture-cum-forestry method.

The wilt and dieback of *shisham* is a common occurrence among small groups of trees growing in water-logged and marshy tracts of *terai* forests in the open land cultivations of crop plants, along the borders of cultivated fields, in the pockets or depressions bordering the highways where soil is frequently dug up for repairs of the roads, in the orchards and tea gardens where the land is ploughed, hoed, manured and irrigated. These are the conditions where *shisham* frequently shows pathological symptoms or signs of ill health.

There are two diseases of *shisham*, wilt and dieback, showing distinct symptoms. These symptoms have been described from time to time in many reports and have occasionally found place in published papers (1), but here they are being enumerated again with the object of giving forest officers a comprehensive idea of the diseases.

The term "wilting" or "withering" is applied (3) to cases where the whole plant dies suddenly* from an attack of fungus located either in the roots or the base of stem. The effects produced on trees are more or less of the same type as those produced by drought or frost, but are distinguished firstly by the absence of these causes, and secondly by their appearance in isolated plants or patches in the affected areas. The trees affected by pure physiological factors revive as soon as the causes are removed, while a tree suffering from pathological wilt never recovers. This disease is identified by the usual symptoms of flagging of leaves, pods and even tender twigs. But other symptoms which are associated with the early stages of dieback such as formation of thin crown, reduction of leaves, yellowing of leaves etc., are also present in wilt.

The wilt is usually apparent after the rains between September and October, but is sometimes noticed in March and April after the flush and also during the rains. The wilt may affect a single tree or a group of trees in close proximity—in lines as in plantations, a few scattered trees in tilled lands or growing on clayey soil in small depressions containing pools of water. In case of *shisham* this disease is not restricted to any definite age though generally young plants between 6 and 10 years of age are more susceptible. Neither can it be said to be restricted to any particular type of soil.

Incidentally it may be mentioned that wilting in juvenile condition is known as "damping off." The damping off of seedlings is also due to various soil-inhabiting fungi, the most prominent being *Rhizoctonia, Pythium, Sclerotinia, Sclerotium*, etc.

The dieback disease has more specialised symptoms than wilt. The dieback of trees

* Heald (7) has used the term **"thrombosis"** of woody plants.
† No. 1 appeared in the issue of October 1944.

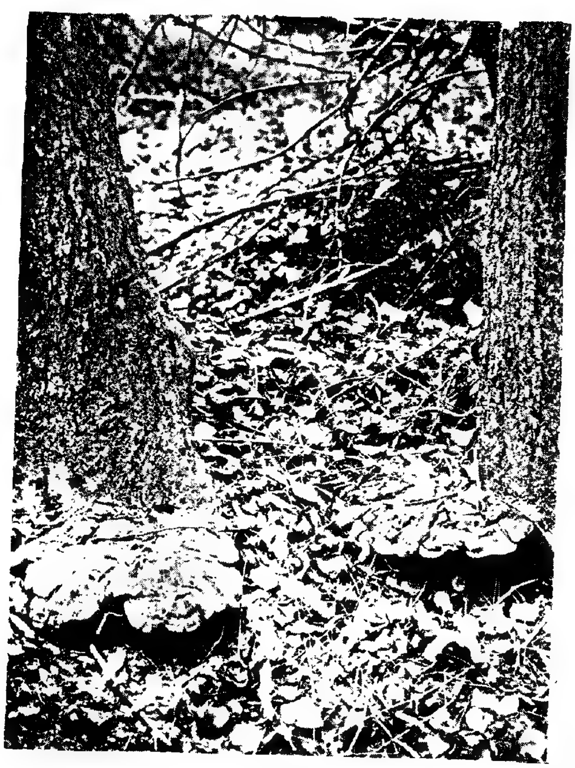
Fig. I

Photograph showing **shisham (Dalbergia Sissoo)** wilt, on Saharanpur Road, Dehra Dun.

Fig. II

Photograph showing dieback of **babul** on the terraces of the Botanical Garden, New Forest, Dehra Dun.

Fig. III.



Photograph of sporophores of **G. lucidum** at the base of **shisham** showing dieback, Changa-manga Plantations, Punjab.

Fig. IV.

Photograph showing stages in the dieback of **shisham** along the border of cultivated fields, Dehra Dun.

takes place by successive stages, the symptoms being thinning of leaves and crown, drying up of the ends of the branches, table-topped condition and stag-headedness in extreme cases. Small dry twigs keep on falling continuously, leaders dry up and the tree looks like a blunt stub containing thick branches. The stages of dieback are illustrated in the photographs in *Figs. II, III and IV of plate 3.*

The Causal Organisms

Isolations were made a number of times previously from the diseased roots of *shisham* and recently from *babul* from Sind, and the fungus was identified as *Fusarium* sp. The fungus produces soft rot of a pinkish-brown colour in the cambium and sapwood, and the bark is readily peeled off from the sapwood. In some cases the rot extends as fine pinkish-brown lines of streaks along the main stem. Inoculation experiments were also carried out with controls on the roots of *shisham* under field conditions in the Doon valley, and the inoculated trees showed signs of typical *Fusarium*-wilt between 3 to 4 years.

The genus *Fusarium* belongs to the class *Deuteromycetes* or the Imperfect Fungi. They are distinguished by the formation of conidiospores occurring in clusters (*acervuli*) without any covering. They are regarded as an imperfect stage of the ascomycetous fungus belonging to the *Hypocreaceæ*. The *Fusariums* causing wilt diseases have not been proved to belong to any known *Ascomycetes*. They live in the conidial stage only and produce rod or sickle-shaped spores.

It is a common soil fungus, the spores of which are present in almost every type of soil; in fact it is difficult to get a sample of soil free from this organism. It becomes parasitic in both acid and alkaline soil. The extremes of pH in the soil help the fungus in its activity by disintegrating the cells of young roots ([1]). In uncultivated or virgin soil the fungus is balanced and remains harmless. This was observed when a survey of the *shisham* wilt was made in the U. P. *terai* forests.

Besides *Fusarium* another fungus belonging to the sclerotial group has been recently isolated from wilted *babul* from the irrigated plantations of Hyderabad, Sind. The pathogenecity of this fungus has not been investigated yet. It is quite possible that a second soil-borne pathogene works jointly with *Fusarium*.

Wilt disease of various economic crop plants is well known for a long time, the wilt disease of pigeon-pea (*Cajanus indica*) was investigated by Butler ([3]) ([4]) ([5]) 35 years ago. The disease was attributed to a fungus which he named *Fusarium udum*. Later on, he came to the conclusion that the fungus was the same as *F. vasinfectum* which attacks another important agricultural crop, namely, cotton. This classical work and its lines of investigation were followed by McRae and Shaw ([6]) who published a monograph on the resistance of pigeon-pea to *F. vasinfectum*.

There are many instances of *fusariosis* in the annual plants known in the science of phytopathology, but only a few of woody trees suffering from vascular wilt. A vascular wilt of Mimosa trees (*Albizzia julibrissin*) is known in America ([7]): the fungus is also a *Fusarium* of the Elegans section (*F. perniciosum*). The disease has been observed on all kinds of soil, ranging from clay to sand and acid to alkaline (pH 4.5 to 7.8), and is due to soil-borne *Fusarium*.

The other instance is the elm wilt in America due to air-borne spores of *Cephalosporium* ([6]), another member of *Deuteromycetes*. The leaves provide the more common infection court and the fungus passes to the stem

Dieback disease of trees may be due to the attack of root-and-stem-rotting parasites which may attack the aerial or underground parts of plants or both. Unlike the wilt disease the pathogene may belong to any group of fungus, though, usually, they are *Ascomycetes* or *Basidiomycetes*. The hosts under reference are *shisham, babul* and *khair* in the *taungyas* and the dieback is due to the attack of a hymenomycetous fungus of parasitic nature, *Ganoderma lucidum Leys.* either alone ([2]) or in conjunction with another fungus of the

same group, namely, *Polyporus gilvus** *Schwein* (8).

The dieback usually affects mature trees, sometimes trees passing on from the pole to the mature stage, less often the young poles and rarely saplings.

The sporophores of *G. lucidum* appear at the base of the tree, on the collar, on the exposed roots or even on the surface of the soil though apparently not in direct connection with the roots of the diseased trees. The soil in the latter case contains a large amount of decomposed wood containing the fungus hyphæ in active condition. In most cases the sporophores are produced when the tree is living but showing dieback symptoms, in other cases they appear after the tree is dead, on the embedded and rotted stump after the tree is cut down. *Polyporus gilvus* and *Ganoderma applanatum* are sometimes associated with *G. lucidum.*

The sporophores of *G. lucidum* are usually annual with heavily laccate or varnished crust, smooth and shining, reddish-brown in colour, adnate to stipitate, stalk stout, context tough, creamy-white throughout except close to the pore-tubes where it darkens to chocolate-brown. The spores are abundant with smooth walls, comparatively light epispores and dark, thick walled, echinulate endospores.

Isolations of *G. lucidum* were made in the past from the sporophores (context) as well as spore-cultures from a large number of *Leguminous* hosts such as *shisham, babul,* cassias, (*C. javanica, C. fistula,* etc.), *Acrocarpus fraxinifolius, Albizzia procera,* etc. which are the common victims of dieback in the New Forest Estate and some of the strains were used for conducting inoculation experiments on young *shisham* grown from root and shoot cuttings (stumps) established in pots. The fungus was introduced through the wounds by Pressler-borer and produced a typical rot in the cambium. The fungus was overcome by the active callous tissue which healed over the wound as the plant grew vigorous. While all attempts to inoculate *shisham* plants, in sterile sand and soil, with spores, context (sporophores cut into cubes and scattered over the pot soil) and mycelial mats from malt agar culture failed to infect the plants.

Numerous isolations were made from the diseased roots of *shisham* and *babul,* and it was found that a hymeno mycetous fungus (recognised by the presence of clamp-connections) was present in almost every isolation associated with a conidial fungus of *Fusarium* type. They were so intricately mixed that all attempts to isolate them failed.

Besides *shisham G. lucidum* causes dieback in a large number of our woody trees in the plains which are of forestry or arboricultural importance such as various spp. of *Acacia, Mimosa, Albizzia, Prosopis, Poinciana, Acrocarpus, Melia, Cedrela, Casuarina, Eucalyptus,* etc. Trees that form road-side avenues bordering metalled surfaces of asphalt, concrete, etc., or on the edges of roads and lawns subject to mowing, heavy rolling, causing root and collar injury, mostly fall victims to *G. lucidum.*

G. lucidum is a fungus of wide distribution, though its activities are most intense in the moist tropics. Its ravages on the *Leguminous* hosts are unparalleled in the history of plant pathology. In an attempt to make a list of its host species consisting principally of woody trees, we have recorded 180 of which 80 per cent are *Leguminoseæ,* 5 per cent *Anacardiaceæ,* 3 per cent *Sapindaceæ.* The list is by no means a complete one and every year a few new hosts are added to it. The Philippine list of the hosts of *G. lucidum* contains 64 spp. of which 31 belong to the *Leguminoseæ.* Selection of immune spp. for *taungya* culture in the plains, is, therefore, a difficult proposition: except for *Bauhinia* all other *Leguminous* spp. are susceptible to some degree.

The fungus also occurs as saprot on the cut stumps of conifers: *Pinus longifolia, Pinus excelsa* and *Cedrus deodara* are the commonest hosts. Oaks (*Q. incana, Q. semecarpifolia*), maples, hornbeams, poplars, rhus, bitter chest-

* The parasitism of **Polyporus gilvus** and other fungi will be a matter of discussion in a subsequent paper.

nuts may be cited as instances among the broad-leaved spp. of the Himalayas.

Like the other soil pathogene, *Fusarium* sp. the fungus *G. lucidum* is to be found everywhere in the plains; in the *terai* land particularly, the sporophores appear even on the cut stumps of perfectly healthy *shisham* within a year of being cut down. Direct control of the fungus also means a great practical difficulty as it means that a vigorous search has to be permanently maintained with periodical eradication of all possible sources of infection such as sporophores, segmented hyphal tissues of the fungus and contaminated woody material. As *G. lucidum* produces conidial spores in culture there is a danger of its likewise producing similar spores in soil and humus and thus disseminating the fungus.

Predisposing Factors

No tree which is not already weakened by predisposing factors and by unsatisfactory conditions can be attacked by fungus. Any factor inimical to the growth requirements can predispose the tree to fungus attack. The very fact that fungus, a constant soil organism, has been successful in penetrating into the tree proves that the conditions of growth have to be investigated into. Fungus attack, in itself is the final proof that all has not been well with the treatment given to the tree. Remedial measures, therefore, must be aimed at to improve the technique.

Let us, therefore, inquire into the present *taungya* technique to determine whether the method itself can be responsible for some predisposing factors or not.

All the trees in some forest area are cut down, roots and stumps removed, and the land is given over to cultivators. They plough the land before the monsoon and sow a *kharif* crop as soon as the monsoon sets in. In Sind the forest trees (*babul* or mulberry) are sown in lines 30 feet apart along with this crop. After the first *kharif* crop the cultivator puts in his *rabi* crop. In the second year again another *kharif* crop is sown, and in the U. P. the forest trees are put in at this time. For two more years the *kharif* and the *rabi* crops are sown alternately, and the cultivator looks after the forest seedlings and weeds them along with his own crops. In Sind, however, this is carried on for one more year and one more *kharif* crop is taken in the fifth year. In all, about 30 floodings are given to the land in Sind during these 5 years but in the U. P. no watering is necessary, the crop depending entirely on rains. Manure is given, if available.

It is possible that frequent cultivation increases the chance of root injury and of secondary infection fungi. Cultivation, therefore, should be restricted after establishing forest trees. Though the disease becomes apparent five or six years after the germination of seeds the infection probably takes place much earlier and the pre emergence period is approximately placed between 2 to 3 years after the plants are established. Frequent cultivation also changes the pH value of the original soil increasing or decreasing the acidity, thereby disturbing the microflora of the soil and upsetting the balance of nutrition. Properly planned experiments are urgently needed at this stage in order to ascertain how many crops could be raised in these plantations without any injury to forest trees.

It is surprising that although the wilt of *shisham*, *babul* and *khair* in the sapling stage is a very persistent menace, the *taungyas* of Dehra Dun and Saharanpur Divisions did not suffer from damping-off in the seedling stage. The pre- and post-emergence of *Fusarium* sp. causing wilt must, therefore, be a different phenomenon than damping-off which takes place under different soil conditions.

Wilt and dieback are two fundamental problems with an all-India importance, particularly in view of the proposal that the forest area in India should be increased to provide the villager with timber and fuel. This will involve the creation of large areas of plantations probably by *taungya*. We cannot overestimate their importance. They have received our attention in the past as already referred to above, and the pathological data collected are now being examined. Projects of further research will be taken up in the next triennial programme of research. Opinions on this subject from the forest officers concerned are, therefore, invited.

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CRYPTOSTEGIA GRANDIFLORA—SOME FURTHER RECORDS OF OCCURRENCE AND AN EXPERIMENT IN GROWING IT FROM SEED

By N. S. Ghate, I.F.S.

When I was on leave at Nagpur (C. P.) during July 1943, I was surprised to find a dried pod of *Cryptostegia grandiflora* picked up out of curiosity by my son from a bungalow compound close to my friend's house at Dhantoli. Later, I discovered that there were quite a large number of plants of this species growing on the compound wall or fence of the bungalow at Dhantoli. After return from leave I was posted as District Forest Officer to Lower Godavari Division, Cocanada. As the climatic conditions obtaining in this division do not differ much from those in the Central Provinces, I wrote to the Provincial Silviculturist, Ootacamund, for supply of a small quantity of seed with a view to try it experimentally in my bungalow compound at Cocanada. He kindly obtained some seed from the Silviculturist, Poona, to whom our thanks are due.

The results of sowing the seeds in my bungalow compound at Cocanada have been quite encouraging. About 2 oz. of seed was sown in seed bed 20 ft. × 1½ ft. on October 2, 1943 and watered twice daily. Germination was noticed on the 5th October 1943. The seedlings were quite healthy and on 31st October 1943 when about 3 inches high, they were transplanted near the Eucalyptus trees (see below) and along the compound fence of my bungalow so that they should have ready support for their tentacles as they grew up. The seedlings are now (in May 1944) 9 inches to 12 inches high and quite healthy. It remains to be seen how they stand the hot weather we are now experiencing.

It was noticed that about 2,100 seeds go to an ounce and that all the seeds had germinated; evidently the seeds must have been really good ones. Out of about 4,200 seedlings about 1,500 survived and are thriving well. The plant per cent may be taken as 35 or 750 seedlings per ounce of seed.

During my camp at Rajahmundry in September 1943, I was surprised to find this plant growing vigorously in the compound of the District Munsiff's Court and also along the canal in Aryapuram. Also I came across a number of plants along the road leading from Bezwada Town to the Railway Station and on the hill just behind the Permanent Way Inspector's quarters at Bezwada. It is surprising to note how this plant is encountered in these two places, namely, Rajahmundry and Bezwada while it is not met with in other parts of Kistna and Godavari Districts.

I found some seedlings raised by the P.W.D. in pots at the Rest House at Addatigala and these have come up well. These seeds were obtained from the Lecturer in Botany, Agricultural College, Coimbatore.

Incidentally the Eucalyptus trees referred to above are said to be *E. rostrata*. They were planted in 1934 and are 40 feet to 50 feet high.

A PLEA FOR DECAPITALISING SPECIFIC NAMES*

By M. B. Raizada, M.Sc.

(Assistant Forest Botanist, Forest Research Institute)

The advantages of decapitalization of specific names are so obvious as scarcely to need elaborate mention. (1) Decapitalization gives uniformity of type. In looking down a list of species one does not want to see disfiguring and disconcerting capitals disrupting the sequence. (2) It saves taking routine thought. The simple rule—do not capitalize any specific names—offers the saving short-cut desired by the busy person who cares for the substance, not the superficialities, of things. (3) It gives distinction to specific names as compared with capitalized generic names.

To start with, I shall narrate some of the arguments put forth by various authorities as to why certain specific names should be capitalized and not others. As is well known our binomial system of higher plants starts with the first edition of Linnæus' *Species Plantarum*, 1753. Linnæus found it expedient to capitalize certain specific epithets but not others. Thus the practice, which is still in vogue, is no doubt of long standing and may be called traditional in the most time-honoured sense.

Practice in capitalizing species names is, however, not mandatory in rules of botanical nomenclature. The latest 'International Rules of Botanical Nomenclature, 1935' only *recommend* "Specific (or other) epithets should be written with a small initial letter, except those which are derived from names of persons (substantive or adjectives) or are taken from generic names (substantive or adjectives)".

Let us now consider as to what exactly is meant by a recommendation. According to Article 2 of the 1935 Rules quoted above "The recommendations deal with subsidiary points, their object being to bring about greater uniformity and clearness in future nomenclature; names or forms contrary to a recommendation *cannot on that account be* rejected, but they are not examples to be followed". Further the rules suggest (Art. 3) that "the rules of nomenclature should be simple and founded on considerations sufficiently clear and forcible for everyone to comprehend and be disposed to accept" and that (Article 4) "the essential points in nomenclature are: (1) to aim at fixity of names; (2) to avoid or to reject the use of forms and names which may cause error or ambiguity or throw science into confusion".

From what has been stated above it is, therefore, clear that the use of capital letters for specific names has been provided by the International Rules *but it is only a recommendation and not a rule* and the only reason for the perpetuation of the existing system of capitalization of specific names is its long 'time-honoured' traditional usage. Britton and Brown [*Illustrated Flora of North United States and Canada 1* (1896) 11] advocate that the system of capitalization should be perpetuated because of its historical importance for they argue that, should the custom of writing all specific names with a small initial letter prevail, much information concerning the history and significance of the specific names would be lost in oblivion. Bailey [*How Plants get their Names* (1933) 131] in support of capital letters writes as follows: "some writers prefer to use no capitals in specific names, not even in those commemorating persons, writing Salvia greggii, Pyrus halliana, Pinus jeffreyi. This is in the interest of uniformity; but uniformity, which is the fetish of standardization, has no supernatural merit. It is much more desirable to maintain dignity and emphasis than to insist on the flatness of regularity. Suggestion of much precious history is lost when the identifying capitals are

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* Bettle's inspiring article on a similar subject [Chron. Botan. VII (1943) 380-381] has prompted me to write this note for the readers of the *Indian Forester*, and has been freely made use of.

deposed." But does this suggest that certain plants are more to be honoured and worthy than others? On the contrary, if it is the memorialized person who is being dignified the rules of nomenclature specifically state that "regard for persons" is a secondary consideration. Are German names of families then, more plebian because they capitalize in their language all nouns? Are American family names more aristocratic because fewer words are capitalized?

Copeland in his article entitled: 'Conventions of botanical nomenclature' [*Science*, 79 (1934) 11-12] emphasised the international aspect of the problem, and warns of the dangers of meddling with rules of botanical nomenclature, even with such a trifling thing as use of capital letters. He writes: "The names of plants are not code designations arbitrarily established and subject to tinkering; they are words of a language, subject to the rules of grammar of the specific language and of language in general". He further adds "One may be jarred, at first, by seeing *californica* written with a small initial; but one realizes that if Germans do not insist on decapitalizing all proper adjectives, Americans need not insist on capitalizing all of them. A person who understands, and is not a hopeless non-conformist, soon becomes heartily reconciled to the system. One foolish individual protests that the state of California is far more important than any individual; another that capitalized specific epithets seem to mar the symmetery of a list. *De gustibus non est disputandum*".

Let us now take the other side of the picture and weigh the merits of decapitalising all specific names. Brown, while discussing 'Pronunciation of botanical terms [*Science*, 78 (1933) 333—335] finds great advantage in the Zoological system of nomenclature and suggests that uniform decapitalization of specific names in botany will be a great improvement over the present system. He writes: "Capitalization of some specific names is approved by most botanists, but is discouraged by many others. Zoologists, however, are now almost a unit in opposition to the practice. The botanists hold that specific names are to be capitalized when (1) the name is derived from that of a person or place and (2) the name is the ancient generic name. The omission of capitals in these instances is scored succinctly by Britton and Brown (*Illustr. Flora of N. U. S. and Canada*, p. 11) 'should this custom prevail, much information concerning the history and significance of the specific names would be lost'. This argument, it seems to me, can be met easily. The professional botanist who does not recognise the name of Engelmann in *Picea engelmanni*, no matter what his other qualifications may be, lacks the historical background and perspective of his subject. To all other persons the name *Picea engelmanni* is merely what it is intended to be, namely, a depersonalized label designating a species of tree. The use of the ancient generic name as a specific name does not elevate the total scientific name to greater distinction than it could have if the specific name were some other word; and capitalizing the name adds nothing to its value but really subtracts from its usefulness, because, apart from its context, it may be confused with a capitalized generic name. . . . Insistence upon capitalization of specific personal names, while earnest and sincere in motive, nevertheless seems to me to smack suspiciously of a subtle form of hero or ancestor worship. The botanists should now without hesitation follow the wise leadership of the zoologists in abandoning the capitalization of all specific names".

A uniformity between the nomenclatorial rules of botany and zoology may seem superfluous in many cases but leads to error and unnecessary confusion where it may be necessary to deal freely with both in the same page. Thus Sharp in his book [*Introduction to Cytology* (1934) 69, 119, 415, 403, 378, 129] has been led into inconsistency by capitalizing Drosera willistoni in one place and decapitalizing it in another. In general Sharp has capitalized specific names of plants where it is recommended but, as one would expect of a worker outside the taxonomic fields, he had difficulty with the more obscure cases. He has correctly capitalized Zea Mays but failed when

he lists Athyrium filix-femina and Humulus lupulus. Similarly Britton in his *Manual of the N. E. States and Canada* capitalizes *Humulus Lupulus* but errs in not capitalizing *Athyrium filix-femina*.

Pennell in *The Scrophulariaceæ of Eastern Temperate North America* [Acad. Nat. Sci. Philadelph. Monograph 1 (1935) 17] has decapitalized all specific names and adds that "this procedure is exceedingly simple and incidentally stresses the equivalence of all species. In the more current botanical practice specific appellations derived from personal names are given undue prominence, while those of generic names used as specific substantives (*e.g. Penstemon Digitalis*) tend to become positively confusing when one is scanning long lists of names to discover the genera involved". Further, he adds in a footnote: "It may be urged that this practice of decapitalization is to be desired but that it should not be adopted now because the International Rules of Botanical Nomenclature recommend that names of species which are derived from personal names or are substantive be written with initial capitals. If the change is desirable, however, it will hardly be made without the previous building up of a sufficient precedent to show how well the practice works." The same author has uniformly used small letters for all specific names in his recent monograph on *The Scrophulariaceæ of the Western Himalayas* [Acad. Nat. Sci. Philadelph Monograph 5 (1943).]

It may, however, be stated that in many instances editorial boards have dictated the procedure followed by various botanists all over the world and should not, therefore, be taken as an indication or expression of the personal opinion and viewpoint of the author. Chase while publishing in *Rhodora* (1904) capitalized specific names but uniformly decapitalized them in *Contributions to the U. S. National Herbarium (1929)*. Cases are, however, not rare where the author is permitted to exercise his own judgment and discretion but they usually occur, as far as I am aware, in less well-known publications than those that conform strictly.

That the movement of decapitalizing all specific names is no minor one is attested by a number of well-known works that have been published during the last two decades or so in widely separate fields, *e.g.* Weaver-Clement's *Plant Ecology (1929)*, Hitchcock's *Manual of the Grasses of the United States (1935)*, Pool's *Flowers and Flowering plants (1929)*, Moss's *Cambridge British flora (1914—1920)*, and several others.

In conclusion, it is strongly urged that in the interests of greater uniformity and increased facility, a changed recommendation be made in the International Rules of Botanical Nomenclature which may provide for the consistent use of decapitalized specific names.

CHEMISTRY AND PAPER MAKING

By

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Introduction.—Paper making and the manufacture of certain textile fabrics are old-established industries based on cellulose as a material of fundamental importance. As a rule, the raw materials, as we find them in nature, are never in a pure state and cellulose is in no way an exception to this. Although obtainable from innumerable sources, it is hardly possible to procure sufficiently pure cellulose for converting it directly into paper. Cotton is the purest form at the disposal of the paper-maker, but certainly, it has never been favoured by him, mainly because of its other various uses.

Paper making, as it stands to-day, is not what it was when in its infancy, "fill the digester with the material in question and put in some caustic soda and water, cover it closely and go on boiling with steam till the man-in-charge thinks that pulp would have been

formed. After washing, beat the pulp and let it run on the machine." Modern process although essentially the same, differs much from that haphazardness.

The Preliminary Process—Its Importance.— The first stage in the manufacture of paper, as also in other industries based on cellulose, is the removal from the raw material of the associated impurities which would otherwise degrade the finished products. The preliminary treatment of the raw material is a process of the greatest importance.

Due to the increasing demands for the better grade products and the competition in the industry, scientific investigators became aware that the efficiency of the preliminary processes would play an important part in maintaining the qualities of the finished products. After a considerable amount of research, it was found possible to remove the contaminating substances *without, at the same time, damaging the mother substance or contaminating it with impurities derived from the substance used for this purpose.*

Chemistry and the Preliminary Process.— Now, it is from this starting point—the preliminary process—till the finish that chemistry helps the paper maker. It is not only the chemicals, *e.g.*, alkalies, lime, bleaching agents, etc., but also the physical, chemical and physico-chemical processes, *e.g.*, solution, peptisation, emulsification, neutralization, oxidation or reduction, etc. etc., that help the paper maker. As a matter of fact, the paper indudstry has developed with the advancement in chemistry. It will not be an exaggeration to say that the modern paper-making industry is a tribute to the learning—chemistry—of the scientific investigators.

A brief survey of paper making processes.— Various chemical processes employed for the manufacture of paper are briefly discussed below from the viewpoint of laying emphasis on the help which chemistry gives to this industry. This is a very brief résumé, which is the only possible thing within the limits of a short article.

1. *Cooking of the raw materials.*—As already mentioned, the object of the preliminary process is the same in all cases, but there are a number of different methods which are available to a paper maker according to his raw materials or the quality of the paper he wants to produce.

All the methods employed are necessarily drastic and involve the use of strong alkalies and chlorine bleaching agents and unless the greatest care is taken serious damage may be caused to the important ingredients of the raw material.

The raw material is digested with alkali or acid liquors. As a rule, most of the associated impurities dissolve and are easily removed by subsequent washings. Chemists have carried out a considerable amount of work to determine the conditions in respect to concentration, temperature, alkali or acid strength of the liquors in the cases of the particular raw materials and these conditions have to be maintained in order to ensure satisfactory removal of the undesirable substances, while at the same time avoiding damage and contamination of the main ingredient.

The work of scientific investigators on the composition and constitution of the complex chemical ingredients of the natural products has been of the greatest value in this connection. The progress made in the study of physical chemistry and physico-chemical processes has also given to the industrial chemists methods of control which were not previously available.

Bleaching Process.—Another part of the preliminary process is bleaching. The pulp obtained by digestion, or by the mechanical grinding of the raw material, is washed and bleached generally with chlorine bleaching agents such as calcium or sodium hypochlorites.

Bleaching and pH control. — Although bleaching is so simple, the paper maker has to work with bleach liquors which, while they effectively and efficiently destroy the colouring matter, do not cause serious damage to the

main ingredient. For this, the paper maker is much indebted to physical chemistry. It has been shown that the *p*H values of bleach liquors have an important influence on their bleaching efficiency. For example, a solution of hypochlorite is more active at the lower *p*H values. Therefore, it has been possible to ascertain the conditions in regard to *p*H values at which the formation of oxy-cellulose becomes active and quantitatively to control the operation of bleaching in such a way that the oxidation of the cellulose is reduced to a minimum while, at the same time, the maximum bleaching effect is obtained.

It will not be out of place to mention here that the *p*H control is necessary not only during bleaching but also in such processes as sizing and colouring of paper which are described below. Similar maxima and minima conditions have been worked out for these as well.

Other bleaching agents.—There are other bleaching agents at the disposal of the paper maker, *e.g.*, liquid chlorine and soda bleach liquor. The last named chemical product is becoming increasingly popular as a bleaching agent because of its cleanliness and high concentration, and it is particularly suitable for use in bleaching processes where the presence of calcium salts is objectionable or undesirable. Another reason for its preference by those paper makers, who manufacture their own caustic soda and chlorine from sodium chloride by the electrolytic process, is the ease with which sodium hypochlorite (soda bleach liquor) can be obtained by a slight modification of the electrolytic process for the preparation of caustic soda and chlorine.

From the little which has been written above about bleaching, it is evident that as a result of the progress made in the chemical industry various chlorine products of high bleaching value are now available. When it is recalled that a little over a hundred years ago bleaching was carried out by the crude and tedious method of exposure to the sun, the great improvement in the manufacture of white paper brought about by chemical research is evident.

2. *Loading, Sizing, etc.*—The next process in paper making, in which chemistry plays an equally important role, is the loading, sizing (*i.e.*, the making of paper impermeable to ink) and colouring of the pulp before conversion into paper. The loading material is used mainly to fill up the spaces between the fibres, making the surface of the paper smooth and capable of taking a high finish.

The type and quantity of the filler used depends on the requirements of the finished paper. Loading the paper tends to increase brittleness and adds to the difficulties in sizing. The substances and the amounts used for loading are, therefore, of very considerable practical importance. The loading materials are generally inorganic substances such as china clay, felspar, etc. Further, considerable chemical research has been carried out with regard to the retention of the filler in the sheet with a view to economy in the cost of production. A filler which is not fully retained cannot usually be recovered and, therefore, means waste.

The purpose of the sizing of paper is to decrease the rate of liquid penetration into the capillaries between the fibres of the sheet. For ordinary writing paper the effect of the sizing material is to prevent the penetration of ink into fibres and thus stop the ink from spreading; whereas in a moisture—or waterproof paper used for various packaging purposes, the sizing is done to avoid the penetration of moisture.

The substances used for sizing are rosin soaps, colloidal rosin solutions, rosin and wax emulsion, etc. This sizing material is precipitated on to the pulp fibres by such agents as (aluminium sulphate) and this precipitate forms a protective film on the sheet during its drying.

Much research work has been done on sizing and precipitating materials, their chemical and physical properties and effects not only on the finished paper but on all the processes which the conversion of pulp to paper involves, retention of the sizing materials by the sheets of paper formed and the maintenance of the optimum *p*H value during the

sizing operation. This research is mainly a question of chemistry.

Similarly for the colouring of paper synthetic as well as vegetable dyes, whose manufacture or extraction is entirely based on chemistry, are used. The process of dyeing is also a chemical reaction involving the precipitation of a dye on the pulp fibres.

2. (*a*) The finishing of the special types of paper are also processes in which the paper maker has need of chemicals and the principles of chemistry govern the selection and use of the agents required. The gelatinizing of the unsized paper sheets by sulphuric acid for making vegetable parchment paper is an important example.

Other Advantages of Chemistry.—Apart from the direct help which chemistry lends to the paper maker there are various other ways in which it helps him. The importance of the purity of the various chemicals especially the caustic alkalies, lime and alum used in the industry and the quality of water for washing the pulps and mixing with stock can hardly be exaggerated. The recovery of caustic soda from the black liquors, a term used to describe the digesting solutions after it has done its work and has taken up the non-cellulosic portions especially the colouring matters and lignins from the plant fibres. has been possible due to the application of the principles of chemistry. All this has helped much to stabilize the industry, reduce the cost of production and make paper according to the requirements.

Conclusion.—A brief outline has been made above to show how the application of scientific methods of research are of value to the paper maker. On going into the details of each of the processes much more could be written.

In the end, it would not be out of place to say here that, although so much research work has been done which has helped the paper industry, there is still much more scope for research to be carried out for the further advancement of this industry. There is an extensive field for scientific investigation in such processes as the pre-treatment of the raw materials, bleaching, sizing, etc. not only with a view to increasing the efficiency of the present methods but also with a view to discovering new methods and reagents which will benefit the industry. So an increasing amount of attention is to be paid by chemists as well as other scientific investigators to the manufacturing processes of the industry to find out more suitable methods of control of the processes and better and cheaper chemicals as well as other raw materials.

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THE GARDEN OF THE WILDERNESS

(A Persia Allegory)

(Rendered into English from the Persian of the learned Hafiz-al-Mansur)

IN THE NAME OF GOD, THE LIVING, THE ETERNAL

Extolled be the perfection of His creation
Who hath clothed the bosoms of the trees with mantles of verdant foliage
And crowned the little twigs with garlands of smiling flowers.
Who feedeth the beasts of the field in the pastures of the wilderness
And giveth rain in due season to water the infant corn.
Before Whose Throne the birds of the air sing their praises
And extol the Glory of the Lord of all the worlds.
God there is no god but Thee; and sufficeth unto me the knowledge of Thee.

The words of the darwesh Abd-al-Illah-al-Hakim-al-Kulani, the keeper of the Garden of the Wilderness (may God enlighten his resting place and keep his memory green for ever) and the story related concerning him.

These things have I, the least of the disciples of the master, written down hereafter that in the reading thereof perchance mankind might be admonished and forsaking the paths of evil walk in the right way—Is it not written:

"Direct us in the right way. In the way of those to whom Thou hast been gracious, not in the way of those against whom Thou art incensed, nor of those who go astray." 1

I, the humble *darwesh,* Abd-al-Illah, wandered in the waste places of the earth, seeking knowledge and undersanding concerning the wilderness and the trees that grow therein, more especially concerning the trees of the forest—how they grow and how they bring forth their little ones to replenish the empty spaces of the earth. I contemplated the many trees that grow in the land of el-Hind and their great diversity, from the thorn tree of the desert and the palm tree of the fountain, to the great *sal* forest which covers a thousand hills with a mantle of green foliage. I beheld the trees of the pastures of the wilderness which stand alone adorned with gorgeous flowers as it were a living flame. I lifted up my eyes to the mountains, whose snow-capped peaks tower up on high to the steps of the Throne of God, and to the vast forest, which clothes the mountains as it were a garment, where the pine tree and the cedar and the fir do dwell. Yet with all this great diversity there was neither chaos nor confusion on the earth but perfect harmony. I saw how every tree had its appointed soil and station, order had superseded chaos. I journeyed over the land of el-Hind, I traversed the sands of the desert and the cultivated plains of the children of men. I crossed range after range of the great mountains and walked on green upland pastures spangled with lovely flowers as it were a carpet of Shíraz embroidered with jewels, and everywhere I beheld the Glory of God and the perfection of His creation.

"Wherever thou turnest thyself about there is the face of God."

In the silence of the forest, where the beams of the sun scarcely penetrate the enchanted gloom beneath the silver fir, I prayed unto my Lord saying, Oh God, the Creator of the heavens and of the earth, if it be Thy will, grant unto Thy servant knowledge of all these things—Even as Thou didst endow Thy servant Suleiman-ibn-Daood with the knowledge of the language of birds, so endow me, even me Thy servant, with knowledge concerning the trees of the forest, how they grow and how they bring forth their little ones to replenish the empty spaces of the earth—Verily all knowledge is of Thee and who shall obtain wisdom save by Thy permission Who knowest all things which have been and all things which shall come to pass, Who art the Fountain of Learning, the All-knowing, the All-wise.

So I continued diligently to seek out knowledge; and, in the fullness of time, the book of the wisdom of the wilderness was opened before my eyes and I read therein all that my heart desired. I became master of the trees of the forest, I marshalled them in their ranks. The breeze of even murmuring in the tree tops told me the secrets of their lives and by the power of my magic they brought forth their little ones to replenish the empty spaces of the earth.

* * *

As I slept beneath the canopy of heaven I dreamed a dream and in my dream I stood on the mountain in the moonlight beneath the widespread branches of a mighty cedar and looked on an enchanted valley bathed in silver light. Around the valley stood the everlasting hills clothed in forest and crowned with glittering snow. And, as I marvelled at the beauty of the scene spread out before me, I heard a voice saying unto me: "Oh faithful servant, unto thee have We given the care of the wilderness, to keep it and order it and beautify it, for therein is our delight." Hearing these words I was filled with fear and prostrated myself beneath the cedar saying, "Oh Lord, be Merciful to Thy servant and give strength unto my hands to perform Thy commands.

* * *

Thus I became the keeper of the wilderness, which is the garden of my Lord, and I laboured therein continually. The years passed, and lo the wilderness blossomed as a garden of roses. The forest stood thick upon a thousand hills and the valleys were green with grass. The wild elephants roamed the solitudes of the forest and the deer brought forth their young in the pastures of the plain and all Nature rejoiced.

"All that is in the heavens and in the earth uttereth the praise of God, the very birds as they spread their wings. Every creature knoweth its prayer and its praise and God knoweth what they do." 2

* * *

Now *Iblees*, the accused, entered into the heart of man saying, "Go up and possess the wilderness and graze your flocks and your herds therein that they may increase and multiply." But man answered Satan saying, "How shall this be? Hath not God given unto us fields to cultivate and pasture for our cattle and hath He not fixed a boundary between us and the wilderness that we overpass not? How then sayest thou, go up and possess the wilderness? Shall not the Lord of all the worlds bring us into judgment?" But Satan mocked man saying, "Hath not God given unto you the dominion of the earth and all that therein is and have not your flocks and your herds increased so that your pasture barely suffices for them? Go up, therefore, and possess the wilderness that your wealth may be increased and who is God that He should regard it?"

The seeds of evil sown by Satan in the heart of men grew and brought forth fruit abundantly. So man went up to possess the wilderness and he grazed his herds in the pastures of the wilderness and his flocks upon the hills. Moreover, he burnt the trees of the forest with fire.

Now the master spake to the people saying: "See ye not the evil that ye do. Repent now and depart unto your own bounds lest the Lord of all the worlds bring you into judgment." But the people answered saying, "Hath not God given unto us the dominion of the earth to do therein that which is right in our eyes? Is not our pasture insufficient

for our needs? Wherefore are we come up to possess the wilderness and who is God that He should regard it? The master answered saying:

"He is the Lord of the East, He is the Lord of the West

and He hath appointed the balance

That in the balance ye should not transgress. 3

But ye have transgressed the balance, ye have not weighed with fairness, ye have scanted the balance: repent, therefore, lest greater evil befall you."

* * *

Now the people regarded not the words of the master and evil and destruction increased upon the earth. The master was old and his heart was heavy and he beheld the work of his life vanishing away, feeling also that his end was near he journeyed into the remoteness of the wilderness where the hand of man had not yet come and rested under an ancient *sal* tree: and he prayed saying, "Oh Lord, look down in mercy upon Thy servant. All my life have I laboured in Thy garden to keep it and order it and beautify it, even as Thou didst command me and now evil is come upon the earth and the garden of the wilderness has become a desolation—Look down, therefore, Oh Lord, and judge whether Thy servant hath done well or ill for the labours of my life are finished." Saying this the master laid himself down beneath the *sal* tree and died. And the birds known in the Persian language as the Seven Brethren spread a pall of *sal* leaves over the body of the master and the angels gathered the soul of the servant of God unto the gradens of Paradise, where beneath the avenues of cypress trees the rivulets of water flow. Where amidst thornless *sidrahs* and *talh* trees clad with fruit and in extended shade and by waters flowing the blest have their reward:

Shall the reward of good be aught but good. 4

Thus died the great *darwesh* Abd-al-Illah-al-Hakim-al-Kulani, the master of the forest, the keeper of the garden of God—His body is buried in peace but his memory liveth for evermore and the memorial of his life's work endureth for generations.

* * *

Evil increased more and more upon the earth. The outer hills were laid bare and naked to the sun, the sheep and the goats devoured every living thing before them. The forest was burnt with fire and the streams became stony torrents. The mountain was scored with running sores and the valleys were choked with sand. Moreover, the land known as the Garden of the Five Rivers became a desolate waste of stones.

* * *

God looked down upon the earth and beheld the evil that man had wrought therein and how the wilderness which aforetime blossomed as a garden of roses had become the abomination of desolation. Also He remembered the words of His servant the master and the answer of the people saying, "Who is God that he should regard it?" and God was filled with anger and indignation; and He spake unto the angel Azræl saying—"Azræl, go forth and draw thy sword against this people for the cup of their iniquity is full and overflowing."

So Azræl went forth and drew his sword and rain came not upon the earth. The cattle were perplexed because they had no pasture. Yea the beasts of the field cried aloud for the streams of water were dried up and the fire had destroyed the pastures of the wilderness The wheat and the barley withered away and there was famine in the land. Then were the fountains of heaven opened and rain descended on the hills. The streams became raging torrents carrying away men and houses and fields and cattle and what the famine had not destroyed the flood destroyed. Then Azræl sent a pestilence upon the earth and those who had escaped the famine and the flood the pestilence slew save only a remnant that fled away into the desert. Azræl sheathed his sword and returned and

stood on the steps of the Throne of God and spake saying: "It is finished even as Thou didst command me."

* * *

Now in the fullness of time, God restored the wilderness as it was aforetime and the wilderness bossomed yet again as a garden of roses. The forest stood thick upon a thousand hills and the valleys were green with grass. The streams again issued clear as crystal out of the mountain to water the pastures of the wilderness. The wild elephants roamed the solitudes of the forest and the deer brought forth their young in the pastures of the plain and all nature rejoiced. The master looked out of the window of Heaven and beheld the wilderness adorned as a bride for her husband and his heart was filled with joy.

Praise be to God, the Living, the Eternal
Whose Throne reacheth over the heavens and over the earth.
And blessing and peace be upon His faithful servant
The Keeper of the Garden of my Lord.

Rest, Oh most excellent of servants.
Rest in the shadow of happiness
During the hours of night and times of day.
While the west wind blows softly o'er the forest
And the moon shines bright upon a thousand hills.

—*Al-Mansür*

WATER SUPPLIES

By J. L. Harrison, I.F.S.

While there has been a great improvement during the past few years in the housing of the forest subordinates (an improvement long overdue and very necessary), the question of the provision of an adequate and clean water supply is often either shelved or given little consideration. Even in bungalows for Gazetted officers little attention is given to this very important question of providing reasonably uncontaminated water. In some cases no suitable water supply is available but, too often, the local water supply is neither efficiently tapped nor safeguarded. Measures to protect available drinking supplies and to minimise any possible pollution can usually readily be taken and are seldom expensive to put into operation. That more illness and epidemics than the normal, do not result, can only be because time has rendered many people immune from reasonable bacterial infection. It is to be hoped that this article may assist in advising what simple measures can be taken, both to increase available supplies and improve the quality of the water.

Water Supplies.—Whatever the source of supply may be, the question is entirely geological. While some rivers have their source in a glacier, for the most part, the water supplies available, depend on the rainfall. In

India, there is a great variation in the rainfall with a resulting great variation in the volume of water available for domestic use. However, the amount of the rainfall is not the important factor in most districts, but the local geological formation and the local vegetative covering. Of the water which falls on the earth's surface some—

(*a*) is taken up again by evaporation and some absorbed by plant life;

(*b*) runs off over the ground surface and finds its way into stream beds, tanks, etc.,

(*c*) soaks into the ground.

Some authorities reckon that each means of disposal takes up one-third.

Much has been written on and fortunately an ever-increasing interest is being taken in the evils of erosion, due to the plant covering on the hill slopes having been reduced and, in some cases, entirely removed. The absence of any vegetative cover on the soil encourages the water to run off very rapidly into *nullahs* and stream beds, the second means of disposal. While a certain amount of such rainfall can be utilised for domestic consumption by taking water from the streams and rivers and for irrigation purposes, this rapid surface flow, not only causes heavy and costly damage to valuable land but is extremely wasteful of water. It is extremely important that water supplies should be conserved, especially in any district where the rainfall is slight. The vegetative cover on the soil, not only slows down the rapid run-off on the hill slopes but, by the probing down into the soil by the roots of the plants, shrubs and trees, often provides channels, owing to later decay of some of the roots, through which the rainfall can soak down into the soil. This surface water will not only percolate through the surface soil but will sink through porous and permeable rocks until it is held up by a layer of impervious rock. Thus in many districts there are underground reservoirs, not only of varying capacity, but where supplies of water are maintained for some months, well into the dry period. The water of atmospheric origin contained in these underground reservoirs is often known as meteoric water. The bottom of any such reservoir is at some indeterminate depth but the surface of the water rises and falls, within definite limits, and this surface is known as the Water Table.

While water for domestic purposes can be collected from the surface streams and ponds, obviously any water, which has been filtered by percolation through the surface soil and permeable rocks, forms a much safer and more suitable source of water and is much to be preferred.

The maintenance and, where necessary, the provision and later maintenance of an adequate vegetative covering to the earth's surface, is a matter for the forest and agricultural experts. The investigation, and later control and tapping of any underground water supplies, is a matter for the geologist, or the engineer with geological training and experience.

Rocks can be classified under two main categories: Igneous and Sedimentary; and, so far as water supply is concerned, only the sedimentary rocks need be considered. The sedimentary rocks were originally laid down in more or less horizontal layers or strata but upheavals in the earth's crust, from time to time, have resulted in some of these strata now being inclined, at times curved and, on occasions, almost vertical. When considering water supply, the strata can be classified either as porous or permeable or as impermeable or impervious rocks. That is a general classification; and, in between these two classifications come strata permeable only in bulk. Rocks of the nature of sand, sandstone, gravel and chalk are permeable. Clay, shale, granite, marble, slate, etc., are some of the impervious rocks. Strata of limestone, marble, slate and granite may allow the passage of water through them by reason of the presence in the rocks of fissures and cracks. The looser the rock deposits, such as sand and gravel, the greater the capacity of the rocks for holding water. Many of the hilly districts of India are of limestone formation which, as already noted, is permeable in mass.

The proportion of the rainfall which soaks into the ground, percolates through the permeable stratum or strata and sinks down until it strikes some impermeable layer, often of the nature of clay. In alluvial plains the strata have not been disturbed to the same extent as in hilly districts, and underneath overlaying layers of silt, sand, gravel, etc., a layer of clay is often to be found, 20 to 3c feet below the surface. In alluvial plains the water table is more or less horizontal although there may be some undulations. The height of this water table will depend on the amount of water stored up and the supplies arriving from the surface absorption of the rainfall. Even in plains the subsurface water is seldom stationary but maintains a constant flow. The rate of flow will depend on the nature of the permeable stratum or strata, in which the water is stored.

In hilly districts, the strata are never horizontal. The inclination of the stratum is known as the dip. Water, stored up in permeable strata, on top of some impermeable layer, will flow down the inclination and will come out on the hillside along the junction of the rocks. Thus, as one would expect, springs are usually to be found in the lower reaches of the main valleys or of the subsidiary valleys. In most cases, water from springs has been well filtered, is free from surface pollution and is usually of a very good quality.

For domestic water supply, if the meteoric water can be readily tapped, such gives the best possible water. We are not concerned with extensive and expensive water supply systems for towns or large communities but for the requirements of, at most, a few hundred people. For our limited requirements the subsurface water can be tapped from springs, in the hilly districts, or by means of wells in the plains.

Springs.—Springs are often designated as Land Springs or Main Springs. Land Springs get their supplies from the local rainfall and are those commonly met with in the hilly districts. Main Springs have their supplies from some deeper located strata and are fed from distant rainfalls. As already noted, by reason of the fact that the water has percolated through the soil, the water in a spring is usually good. The danger of pollution arises from surface pollution near its outlet, pollution due to animal or man or both. Springs often come out as ill-defined soakage but the outlet is usually well-defined. Springs are sometimes found on flat ground but for the most part come out on some slope. In the case of a spring, bubbling up on flat ground, the area round about the spring should be well cleared and a wall built round and the site covered in. *Fig. 1 in Plate 4* illustrates the type of spring sometimes met with on flattish ground and the measures taken to improve and protect the supply. From the reservoir a pipe can be led off.

Where the outlet is on a hillside, as shewn in *Fig. 2 of Plate 4*, this outlet should be opened up until the main flow is laid bare. The opening up of a spring very often increases the flow. A small tunnel should then be driven into the hillside and this chamber should be walled up, in front, with a wall of stone or brick in mortar or a wall of concrete. The chamber should also be roofed with stone or brick and have the side walls built up but the back, of course, is left as it is, for the water to come through. An outlet pipe is fitted in the front wall, some height above the bottom and a second pipe can be fitted at ground level so that the water chamber can be readily cleaned out from time to time. In a spring of this nature (as even more so in the case of a spring on slightly sloping ground) there is danger of surface pollution and, in addition to leaving as great a depth of soil as possible above the outlet of the spring, an area should be fenced off above and around the outlet, sufficient to prevent pollution by man and or beast.

Wells.—While wells are sometimes sunk in hilly districts in the stream beds, in the river valleys or in some other form of watercourse they are usually to be found in the plains, where the strata are more undisturbed and more horizontal. Districts of alluvial formation offer the best possibilities. The selection

WATER SUPPLIES

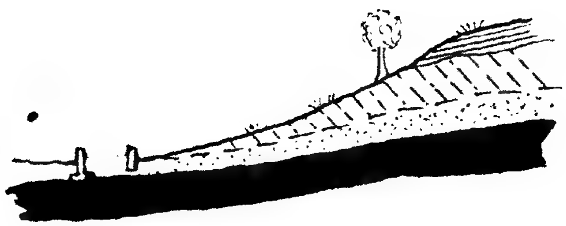


Fig. 1.

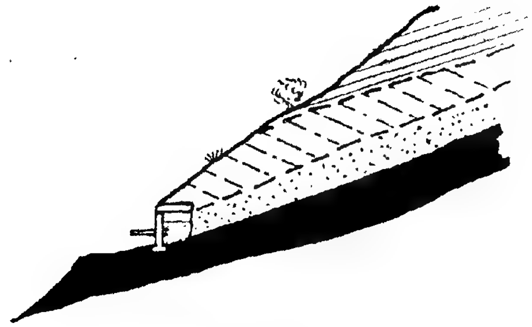
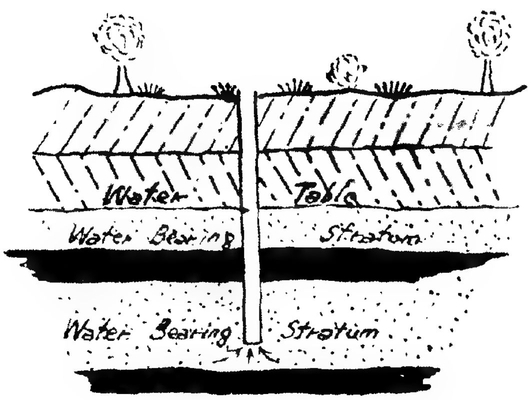


Fig. 2.



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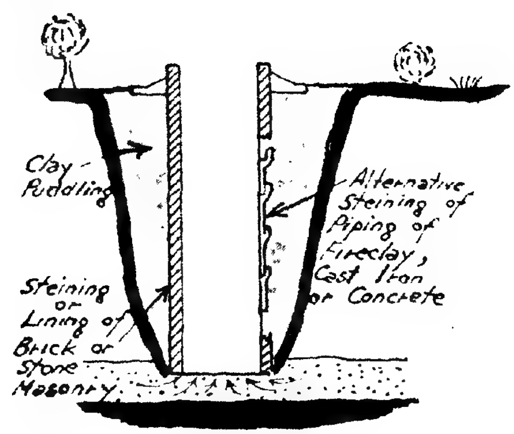


Fig. 4.

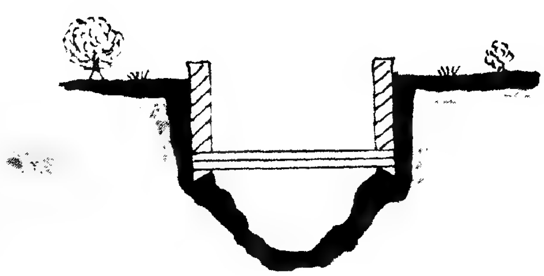


Fig. 5.

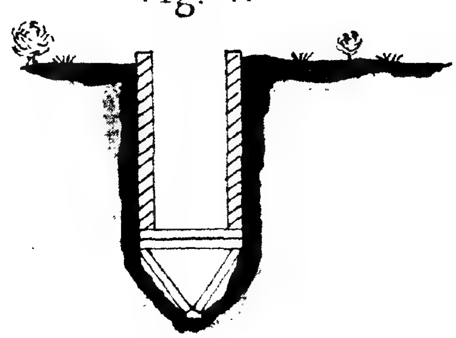


Fig. 6.

of the most suitable site for a well and a decision as regards the depth to which it should be sunk, the size and the nature of the construction, require, if not the services of an expert, at least consultation with the more intelligent of the local inhabitants. If there are any adjoining wells, these will give an idea of the possibilities as regards quantity and quality of water and will show the local geological formation. Shallow wells may obtain their supplies from surface water, from stores of water underground, held up by some impervious layer, from water filtering through some adjoining streams or from a combination of two or three of such sources of supply. Surface water will contaminate a well and all steps possible should be taken to prevent either surface water or water previously drawn from the well from flowing direct into the well. A shallow well, sunk near a stream, gives a supply of filtered water and, although filtering alone will not purify water, filtering does remove a lot of the suspended matter. Normally a well is sunk through various permeable strata, through which the surface water has filtered, down to the supplies of underground water held up by some impervious layer. The permeable strata usually consist of soils such as silt, sand and gravel and the impervious stratum, clay. While the depth to which a well should be sunk and its probable yield can sometimes be decided by an expert, such have usually to be decided by experiment. It is seldom advisable to sink a well in the higher reaches in a hilly district because all the time the water is flowing downhill, at varying rates of flow, through the permeable strata and, unless supplies of surface water are ample, any such well would soon dry up, and would remain dry until the rainfall filled the permeable strata with further supplies. In fixing the site of a well, the services of a water diviner (or dowser, as he is sometimes called) may be of value although I have no personal experience of the value or otherwise of such methods.

Once a well has been sunk, then, by pumping or baling out the water, an estimate can be made of the probable supply, at various times of the year. In most cases the level will rise and fall according to the level of the water table. Where several wells are sunk in an area, each new well sunk may result in a diminution in the supply available in each well by reason of the fact that, if the underground supplies are limited, the more the tappings of the supply which are made, the less the flow at each.

Wells may be Shallow or Deep. Wells down to 30 feet in depth are usually considered to be shallow wells. Formerly deep wells of up to 100 feet in depth were sunk but nowadays such deep wells are seldom sunk and well-boring plants are used instead to sink tube-wells. In sinking a shallow well, it may be that an impervious layer holding up a certain supply of water may be struck fairly near the surface. While the probable supply up to that depth may be small, it may be that such supply is sufficient. If it is decided to excavate down through that impervious stratum in the hope of striking greater supplies of water lower down, held up by some lower impervious stratum, there is a danger of losing the water supply entirely. The illustration in *Fig. 3 of Plate 4* shows a shallow well sunk down through one impervious stratum to tap the water supplies lower down. Any decision, whether to stop at the first impervious stratum or to take a chance and go lower down, has to be made on the spot and will be governed by factors such as daily requirements of water, etc. Where the depth of a well is rather less than normal, the capacity can often be increased by increasing the diameter.

Construction of Shallow Wells.—Where a well is given no lining or "steining," as it is called, the well is known as a surface well. This is a very temporary supply and difficult to keep uncontaminated. In the case of a shallow well with a lining or steining, there are three methods which can be employed:

(*a*) The well is excavated to the required depth, a foundation is given for the steining and the steining is built up on that foundation. In *Fig. 4 of Plate 4*, a well of this nature is shewn. The steining may be of

walling of brick or stone in mortar, of fireclay piping, steel piping, or of concrete piping. Whereas steinings were formerly of brick or stone walling, nowadays increasing use is being made of piping, fireclay where locally available, or concrete. The piping of fireclay is in convenient lengths of around 3 feet and is so designed that lengths can readily be fitted together and the joints sealed. The type of joint is shewn at the right-hand side of the well in *Fig. 4*. The advantage of concrete pipes is that these pipes can be made at or near the well site and can be designed in lengths to be readily fitted together and sealed with cement.

When a well is being excavated, it is best to employ trained labour with some knowledge of well sinking. Where the soil is reasonably firm, excavation can be carried out with the sides of the excavation almost vertical. If the soil is at all uncertain, a slope has to be left. Well sinking is usually carried out in the hot weather, when the water table is at its lowest.

The steining not only holds up the sides of the excavation but prevents any surface water from soaking direct into the well. Behind the steining is often filled in with puddled clay (as shewn in *Fig 4*) to give further protection.

(*b*) Where the soil is unstable and where the depth of the well to be sunk is too great to allow of such sinking being done without support to the sides of the excavation, a curb is first laid on the ground and a certain height of steining is built up on that curb. The curb is made of timber framing in the shape of a flat ring. The curb has its internal diameter, the diameter which it is proposed to give the finished well and the width of the ring is the width of the steining. The upper face of the curb ring is flat but the under face has a cutting edge to facilitate the penetration into the ground. As the curb remains in the well after it has been built, some suitable species for the construction of the curb has to be selected. Suitable species include some of the Ficus spp., bombax, mango, *shisham* and *sal*. A certain height of steining is built up on the curb and the earth is excavated from the centre of the well and from underneath the curb. The weight on top of the curb and the excavation of the earth from underneath causes the curb to sink. When the curb has sunk so far, further steining is built up and the sinking proceeds. The construction is as shewn in *Fig. 5 of Plate 4*. It will be appreciated that with this method of well sinking it is extremely important that the steining be carefully built up so that the curb is evenly loaded all round and that the steining should be taken down, truly vertical. In addition to the weight of masonry or brickwork of the steining, extra weights may have to be added to force the steining down. The extra weights are best added by means of a controlled framework so that even settlement can be arranged.

In place of the well curb being laid on the ground surface and excavation proceeding from there, an initial excavation can be made, down to a depth at which there is no fear of the walls of the excavation caving in. The bottom of that shaft can then be carefully levelled and on that level surface the curb can be laid and a steining built upon it. Excavation can then proceed as noted above.

(*c*) A third method of sinking a well is to excavate down to a depth at which the walls of the shaft will not collapse. The diameter of the excavation will, in any case, be at least two feet greater than the external diameter of the steining. The excavation is usually in the shape of an inverted truncated cone.

At a safe depth, a curb is laid and levelled off and on this curb the steining is built up. Excavation then goes on in the centre of the curb and, at some suitable depth, a block is laid on virgin soil in the centre of the excavation. From this centre block struts are fixed to the underside of the curb and then the soil at the sides, and directly under the curb, can be excavated. A curb is laid at the same depth as the central block and the steining is built up to the underside of the top curb. The supporting struts can then be removed. Further excavation proceeds down from the second curb and later this is also strutted. In

this way, excavation can go down by stages until the required depth of well has been reached. The construction is as shewn in *Fig. 6 of Plate 4*.

Driven Tube-Wells.—Nowadays wells are seldom sunk to any depth and underground water supplies are tapped by means of tube-wells. The method merely consists of driving a pipe down into the ground until the underground water supplies are reached. For extensive supplies, tubes of large diameter are driven by special well-driving equipment and by skilled labour. For Forest Department supplies, where only hundreds of gallons are required, the readily-driven tube-wells, often known as Norton Tube-wells, are installed. In these wells, metal tubing of an internal diameter of around $1\frac{1}{4}$ in. is driven into the ground until a water-bearing stratum is reached. The driving is done by means of a light metal monkey and the work can be carried out by unskilled labour under reasonably intelligent supervision. The tubing is in lengths, one end screwed and the other end with a socket into which the adjacent length can be screwed. At the driving end of the first length, there is a steel point, which point can readily go through ordinary soil and is capable of penetrating soil almost up to the hardness of chalk. Above the steel point, there are perforations in the tube and through these perforations the water can enter the tube.

Once one length has been driven down with the upper end almost at ground level, another length of piping is screwed on and the driving continued.

With tube-driving, care must be exercised that the point of the tube is not driven through a water-bearing stratum down into some lower impermeable stratum. Usually some information is available regarding the general geological formation of the locality in question to give some general idea at which approximate depth the first water-bearing stratum will be struck. By lowering a small plumb line, down inside the tubing, the well can be sounded from time to time.

With open wells there is always a danger of surface water soaking into the well and causing contamination. With tube-wells, the soil is tightly packed around the outside of the piping and even if water is lying around on the ground where the pipe comes out, by the time it has soaked down to the stratum being tapped (if any ever gets there at all) it has at least been well filtered. As can be realised, the water from a tube-well is cleaner than that from a surface well. Driving tube-wells is a quicker and cheaper method of tapping underground storage. The great disadvantage is that tube-wells cannot be used unless the water inside the tube rises to within 20 feet of the surface. The reason for that is obvious as the water in the tubing has to be raised to the surface by means of a pump and water cannot be raised by suction from a depth greater than 25 to 30 feet and at the greater depth only when the pump is in first-class working order and when the joint between the pump and the top of the piping is absolutely airtight.

In some soils, the bottom of the pipe tends to get choked with fine particles of soil blocking up the many fine perforations. There is a set of special cleaning tubes for cleaning the bottom of a choked pipe.

Where drinking water supplies are obtained from streams, the beneficial action of the sun helps to minimise trouble due to water contamination. If shallow wells are sunk these help to keep the water supply free from outside pollution and tube-wells give greater protection against surface pollution. Open tanks and ponds can be protected by having strong fencing around them to keep off animals but there is almost as great danger due to human pollution. All drinking water should be boiled but while some of the staff may be educated up to taking such an elementary precaution, where the needs of a large labour force have to be met, labour will certainly not take the trouble to boil any water before drinking it. That more epidemics than normal do not result can only be because time has rendered many of the villagers immune from bacterial infection.

Where water supplies have to be provided for a large labour force, unless adequate supplies are available from a stream, spring, or a well, or wells, provision has to be made for storage. For storage of water galvanized-iron tanks are the most convenient and if several of these are fitted, this gives an opportunity for purifying the water and keeping it reasonably contaminated. The galvanized tanks are of varying capacity but a useful size is a tank of four-foot cube. This size of tank is easy to handle and transport and has a capacity of about 400 gallons. Tanks of this size can be connected up in series to give the required storage capacity.

The filling of the tanks can be done by gravity or by pumping. Where there is gravity feed by an open channel, provided there is a down grade, there is no difficulty but, if there is gravity feed through a pipe, it has to be remembered that friction inside the pipe has to be overcome and, for an adequate flow through the pipe, there must be sufficient head at the main supply. Various types of pumps are available, hand-operated and capable of lifting water from a depth of up to 18 feet and forcing it up to a height of as much as 50 feet. The capacity of delivery varies according to the size of the pump and is from five to thirty gallons per minute. The capacity of power-operated pumps is, of course, correspondingly greater.

Where pumps are used the points to be noted are that the pump should be securely anchored down to some base plate or other type of foundation and that all connections should be as airtight as possible to get the maximum efficiency from the pump. Where a strainer is fitted on the end of the intake pipe, this strainer should not rest on the ground otherwise soil particles are stirred up and clear water is not raised.

Sterilization.—Clear water does not necessarily mean pure water and while a large proportion of the bacteria in water can be removed by clarification, that is, by removing the suspended matter, there are often bacteria remaining. Where filtration can be arranged so much the better and the pathogenic bacteria remaining in the water after this clarification, can be dealt with by sterilization, that is, by chemical action. There is no need to consider large-scale water purification schemes and in the meantime, I propose to deal with some of the commoner sterilization agents which can be applied by anyone.

Chlorine.—Filtration is necessary before chlorine can efficiently be used. A dose of 1 part of chlorine to 1,000,000 parts of water is considered sufficient. If there are more than 2 parts of chlorine to 1,000,000 parts of water, the water is unpalatable but, in order to obtain the necessary 1 part of chlorine to 1,000,000 parts of water, slightly excess chlorine has to be added as some of the chlorine is taken up by the organic and inorganic matter found in the water. The commonest and cheapest agent is chloride of lime or, as it is often known, bleaching powder. The chloride of lime is supplied in powder form and, if at all lumpy, should be reduced to a fine powder before use. The minimum period of contact is half an hour and, if a large supply of water were required, two lots of storage tanks would be necessary. Any excess chlorine can be removed by the use of sodium thiosulphate. The Army, for sterilization, make use of chlorine in the form of Water Sterilizing Powder. This is a mixture of 4 parts of bleaching powder with 1 part of quicklime and the powder is made up in tins of $\frac{1}{4}$-lb. and 30-lbs. This powder has an available chlorine content of 25 per cent. A more recent Army preparation, known as Chlorosene, also a water-sterilizing powder, has an available chlorine content of 30 per cent.

Alternative sterilizing agents are potassium permanganate and copper sulphate. Potassium permanganate is more expensive than chloride of lime, and is not considered very reliable for the destruction of organisms other than those causing cholera. Moreover, its use makes the water discoloured and hence not attractive.

Copper sulphate is used mainly for killing off and keeping down the algæ rather than as

a sterilizing agent but, if no other agent is available, it is, to a certain extent, effective.

Where water, in small quantities, has to be sterilized, iodine, which is usually readily procurable, may be used. The proportion to be employed is three drops of tincture of iodine to one pint of water.

The Army have a sterilizing agent for the treatment of water in small quantities, sodium bisulphate or acid sodium sulphate ($NaHSO_4$). This is in tablet form, each tablet having 15 grains of sodium bisulphate, mixed with some oil of lemon and saccharine. One tablet is used with each pint of water and the water is fit to drink after half an hour's contact.

I would repeat that the one safe, cheap and easy method of sterilization is boiling and if water is boiled for five minutes, it should be safe for drinking. Boiled water is, admittedly, flat and insipid, but that condition is better than the alternative.

Testing of water can be carried out properly only by a qualified chemist. If a proper report on the quality of water from any source is desired, representative samples of the water in sealed bottles have to be sent to some authority for test and report.

FIRST DAY IN THE FOREST

BY J. N. SINHA

(Divisional Forest Officer, Dhalbhum Forest Division)

For practical training prior to appointment I was ordered to join at Chotanagra. The order concluded with the information that to do so I would have to detrain at Manoharpur. Sitting in my college hostel I tried to figure it out. To join service one goes from village to the town, from town to the city. How was it then that I did not know such an important place as Chotanagra where I was going to begin a career of life? I looked so small before myself. Such a colossal, pitiful ignorance of elementary geography! That Chotanagra was not connected by rail meant nothing against its importance. It rather sent a halo around it for were not the pick of hill-stations like Mussoorie and Shillong majestically aloof from the madding crowds of rail-head? Why, even Hazaribagh nearer home had no rail access. True it was, of course, that I was going to join the forest service. But what need for a forest officer to live anywhere near the forest? What was to be done in a forest but to sell trees which some martyr-spirited adventurous contractor undertook to cut and remove? Occasionally the forest officer did journey out from the town but, that he did in a ceremonious manner, on the back of an elephant tastefully caparisoned, with band playing all round to keep wild animals away. I do not know how these vivid details of a forest officer's duties came to secure a lodgment in my mind but the picture was strongly set therein. In my picture wild animals so thickly abounded the forest that, until a sufficient number of lusty drum-beaters made a tight ring around and advanced with that ring unbroken, the elephant bearing the officer could not advance for sheer density of the wild beasts. The latter, I imagined, persistently beat against that ring in the manner of urchins at the sports prize distribution. What were regulation *lathis* to these urchins was a band to the wild animals. Whether the band worked on the jungle beasts through love or through fear I cannot recall, nor why there was absence of a gun from the picture. I remember, however, that Gandhiji's non-violence had just taken the field those days.

So I started for Chotanagra. The booking clerk at Patna station blinked at me awhile when I asked for a ticket to Manoharpur. It took a little of the wind out of the sails of my exuberant enthusiasm when the clerk, after laboriously scanning a number of fat volumes, ultimately produced a paper ticket to my destination.

The following morning, nearing Manoharpur, I was sauntering on a platform, shyly peeping about at the new world of mine. A tall, thick, swarthy gentleman, also sauntering along, stopped and, unprovoked, stood over me like the mountain over a mound. Perhaps my bewildered look had drawn his patronising attention. Announcing that he was a forest ranger he asked where I was going.

"To join the forest service," I answered.

"Have you passed your Matriculation?"

"I have passed my B.Sc."

He peered at me awhile. The intensity of his fixed gaze subdued me altogether "And still you are going to be a Forester?" he asked at length.

Before I could collect myself together to answer, "Well, well" he said, "give my *salams* to the Ranger Sahib at Manoharpur." I had not concluded my reflections on the strange, jerky temperament of these forest climes when the raucous shriek of the B.N.R. engine ordered me shabbily back to my compartment.

Manoharpur looked disappointingly and derisively small for such an important place as Chotanagra which was going to be the seat of commencement of my career. Yet many a famed hill station had unostentatious rail-

heads. What did that matter? I told the porters I would go to Chotanagra. That seemed to mean nothing to them. I asked the station officials. They too were in a state of most reprehensible ignorance. The atmosphere around was depressingly quiet, almost sleepy. Not a horse neighed, no bus engine spluttered, no taxi hooted. I went to the Range Office. The very look of the Ranger in charge unfortunately reminded me uncomfortably of the jerky, overbearing gentleman I had collided against in the morning. "I have to go to Chotanagra," I said.

"I know," he replied quietly and confidently.

"I have to go there to-day."

"You can't."

"But these are my orders; I must join there to-day."

"You can't."

These unhelpful, laconic answers annoyed me. Even though as I sat there, I had the feelings of a man standing under an unstable overhanging massive boulder, I remembered I was an officer in the making and must assert. "But why can't I?" I asked with dignity; "if buses will not take me in time I am prepared to take a taxi."

"You can't," repeated that mountain of a Ranger.

The pan can sometimes become too hot to boil water. Unmeasured mystery jostling with deep annoyance held me. "How then do people go to Chotanagra?" I asked with great self-control.

"By trudging twenty miles with patience and luck."

By trudging twenty miles!

"And how does the kit go?"

"On coolies."

A strange hill station, this Chotanagra! Very backward!

I had a cycle with me. The romantic dash that had urged me to a forest career now asserted itself. "I can go by cycle," I offered, "and the servant can follow with the kit."

"Don't stray from the men, is my advice," said the Range Officer. "Your cycle will be of no use."

Settling down to realities, I left for Chotanagra about 5 p.m. Earlier than that coolies would not be available, it being a *hat* day (what parents of inconvenience, these *hat* days! I thought). Soon a lashing stream cut the road. Why no bridge, I wondered. I had the novel experience of a precarious seat on the joined hands of the coolies whereby the stream was manœuvred. Then came wide expanses of rolling countryside delightfully dotted with houses and trees and ending in bulwarks of blue hills. The red murrum road, twisting and turning like the jerk dancers of European summer evenings, played hide-and-seek with green groves and brown mounds. Cattle were returning from pasture. Cowherds piping. Smoke lazily emerging from the thatched houses. I felt as happy as the schoolboy on his cherished holiday. Departing sun left behind a young moon. Peeping through the tops of young pointed *sal* saplings or sailing through wavy banks of clouds over the hazy hills the moon turned the landscape into a page of dreamy romance. Nature was going to sleep and this gentle guardian was singing a silent lullaby.

I was braced for a journey through to Chotanagra. The romance was gripping. Where was the danger of which the ranger had needlessly frightened me? But when the forest thickened a little the coolies left the road and in a thatched hut deposited my kit and departed. There in Kolbonga village I was to spend the night.

As I lay in the cosy comfort of the straw bed I listened to the silence of night. From the trees outside came a continuous musical sound of drip-drip. I thought it was raining but later knew that it was only the copious dewfall of forest areas. And from across the stillness of the night came a medley onslaught of unmusical sound—sharp, shrill and piercing like the bowman's arrows that have missed the mark; or muffled and rounded like the wild wave of the wrestler's club. The

agriculturists were guarding their little precious crop against the marauders of the dark by night-long yells of varied note and pitch and by beating the canister, the tom-tom or anything that came handy. The wild elephant, the *sambhar,* the deer, I was told, would otherwise make a night's meal of months' labour. The opposing armies are constantly arrayed on the frontier. In the *Mahabharat* there used to be fight by day and truce by night. Here the day has the truce and night sees the fight. Truly the forest-dweller's life is a veritable *mahabharat.*

The following morning search for coolies was unavailing. Few understood us, nobody listened. When the day advanced to two in the afternoon I could tarry no longer. I was already late by one day. I rolled a woollen shawl in paper and tied it to the luggage carrier of my cycle. Dressed in shorts and a warm coat I set out alone, leaving my servant to follow as soon as coolies were available. I stuffed my coat pockets with dry fruits that I had brought with me.

For some distance a hut here or there kept me tuned to the world of man. Then the huts disappeared. Thick jungle appeared. I hurried on to get to the other side of the jungle. I had seen so many big gardens, the jungle could not go on very long. But the jungle went ahead as fast as I did. Shades began to grow darker. Tree tops touched above the road. Nothing but jungle all around. The road was, however, sloping down, the cycle speeding fast, and the edge of my sensations was taken away by the speed. Shortly afterwards came a noisy hill stream tumbling restlessly over stones and boulders and obliterated the road. I dismounted. I had read in books of babbling brooks that sing their course through sylvan shades. In Nature's music poets have heard the message of eternity and from that lisp learnt the wisdom of ages. I looked about enthralled, and listened. But the fearsome stillness, only made the deeper by the gurgling sound, jerked me back into consciousness. There was impenetrable deep forest on all sides And from all sides the dark forest appeared to be closing in to swallow and digest me. Somehow, therefore, I forded the stream and hurried forward. Ahead the road rose towards the hill-top. I laboured up with the cycle. The forest grew darker and denser and more fearful. Tall skyscraping *sal* trees stood shoulder to shoulder and crowds of climbers wove death-nets between them, even the sun's rays struggling to penetrate beat in vain. There was no sign of life anywhere. It looked as if the world of the living had ended and the world of dark death begun. I hurried on, hoping that the next bend would take me out of the jungle. But the next bend only lured me to the third, and the third to the fourth. The jungle, instead of ending, grew more unending, denser and more fearsome. Fear now clutched at my heart. What if a tiger sprang out of the dark foliage and carried me away? What if a demon of the forest took shape out of the vacuum in front and, laughing maliciously through his long, protruding teeth at the folly and helplessness of a poor, ignorant college boy—what if such a dreadful demon made pulp out of me between his long-nailed, convulsive fingers? Why, even the wild elephant might come crashing down the slope to the right and sweep me away. The wily bear might bob out of the abyss to the left and maul the skin off my face and head. My heart began to beat like the drunken village drum. Beads of perspiration poured down my brow like drops of rain in a summer shower. I began to repent of my folly in disregarding the wise ranger's advice. How I loved the man! For a moment I halted and the helpless eyes yearningly looked back. Return? But return seemed impossible. I had already come too far. Ahead the jungle might end sooner, whereas behind the sleeping animals, whom I had eluded, must have been awakened by now. Thoughts went home—to the people who loved me, who had knit their life with mine. Their love and their burden made me still more miserable. How could those loving, hoping hearts even imagine that I would wrong them by thus walking with my eyes open into this overwhelming death-trap? Thoughts then went

to God. Spare me this time, O God! I prayed, and I will never repeat this folly. Never, never again. But nothing relieved the dark prospects of a certain death. I had my ambitions, my plans for the family and society. All that I could do now was to leave behind a will embodying these. So, as I went along, the will was being drafted mentally. Motion somehow seemed safer than rest so, though down and out, I staggered along as one possessed, stopping only for brief circumspect moments to eat dry fruits and quench the overpowering thirst at the little rills that ran across the road.

At last, at long last, having covered countless miles, after the boundary between life and death had become blurred, when life seemed as immaterial as death, the road commenced to descend. Suddenly hope shot through the sinking heart. The embers glowed. Careering at breakneck speed round sharp bends, skirting the edges of bottomless ravines, ploughing through clogging dust, trundling over stone obstructions, I reached -- again after countless miles—what looked like a populous town. With an invisible halo of triumph I dismounted. But Chotanagra was still six miles away. That was Ponga (what names these! I wondered), a European company's temporary timber establishment.

The Divisional Forest Officer, after brief, heartless enquiries (for my graphic description of the dark forest and the danger I had gone through *sounded little to him) sent me* for shelter to the subordinates' rest shed. A few, miserable, scattered huts in a wide opening among these malarial hills were all that made up the much-spoken-of Chotanagra. The rest-shed lay a long way from the village, in the murky, sombre surroundings of damp, dark foliage. It was dismally quiet and lonely. Here to spend the night? However, after a meal of my dry fruits, I sprawled on the string bed spread over the straw. The thin shawl was all the cover. Though the twilight had already yet given way to darkness, sleep descended and settled the battle of fear and hope.

At what seemed to be dead of night there came a knock at the door. I woke up with a start and sweated with fright. But it was only the Divisional Forest Officer's man with steaming rice and curry. I gulped it down with gratitude and resumed the sleep. The thin shawl beat the biting cold, and who has known such restful sleep!

Recently, as Divisional Forest Officer, I went over the same road. With me was a novelist of renown. While my friend gaped with awe at the scene around and wrote an ode to the courage of a college student, I wished the poor Quality III trees were taller and thicker, the density were greater, the partial blanks were more fully stocked, that there were more wild animals and less traffic on the roads!

बाग़ की दौलत

THE METHOD OF GREEN COMPOSTING (OR PRODUCING COMPOST FROM WEEDS.)

BY V. K. MAITLAND .
(Conservator of Forests, Eastern Circle, C.P.)

The following notes describe a simple method of preparing compost (a most valuable form of plant food) from ingredients which are available in almost every compound, village or municipality and it is considered that the method should be made familiar to every one. It should also be taught in all schools as a matter of routine.

Dig a convenient-sized pit not less than 6 feet × 10 feet and 4 feet deep. Arrange for a very slight slope to one end for drainage. Uproot all green weeds available and collect any other green vegetable rubbish. (Soil adhering to roots is very valuable—it helps to make compost.) Place the uprooted weeds with adhering soil in a layer 1 foot deep in the bottom of the pit as compactly as possible. Leave about 1 foot at the lowest end clear, so that when the pit is filled excess moisture can be baled out. Cover the green layer with a 1 foot layer of manure—cowdung, stable litter, horse dung or anything of the sort available. Cover this with another layer of green weeds and vegetable refuse. Cover this with another layer of dung—and repeat this alternate layering of green material and manure till the heap is 4 feet above ground level, *i.e.*, 8 feet high from the bottom of the pit. Each layer of manure on completion must be well soaked with water. About 6 pailfuls will do for each manure layer in a pit of the minimum size indicated. If any fine earth is available from the clearing of *e.g.*, drains and small surface ditches, add this—it will all make good compost as it is finely divided and contains an active soil bacteria population. Green layers or layers of soil from drains being already moist enough require no extra water when the heap is being formed.

If urine-earth is available, *i.e.*, earth soaked in urine such as may be found round cattle sheds or stables, add all you can get. Animal urine can also be with great advantage added to the heap. If ordinary surface earth is used only the top 1 inch of top soil is suitable. (Deeper earth is too compacted to make compost.)

The weight of the completed heap will express a good deal of liquid. This will collect in the drainage pit (at the end of the compost pit) and can be baled out and used directly as liquid manure—or (if the upper layers of the pit are dry) poured back on the top.

During the rains when green weeds are abundant the drainage pit must be frequently emptied as standing water in the compost pit stops bacterial action and fermentation.

In the open season the drainage pit can be filled up with similar alternate layers of green stuff and manure, and, in order to prevent loss of moisture by evaporation the whole heap should be covered with leaf mould or, if this is not available, fine *earth* except for a few small holes at the top into which water can be poured. Leaf mould is the best covering as it is porous and admits a little air.

The compost heap must be kept moist until 4 months have elapsed or until the heap has reached ground level (whichever occurs first). Standing water in the lower part of the pit must, however, *never* be allowed to accumulate and rise in the pit. Addition of water or liquid manure is all that is necessary once the heap is completed but this small amount of attention is essential. Once a week this addition must be made. If weak solution liquid manure is available, this is an improvement on plain water. Liquid manure must be very

thin and watery, however, otherwise, it just sticks on the top, dries out and forms an impenetrable covering.

The compost heap gets hot in a few days and rapidly sinks—as fermentation proceeds. The whole process is completed in 4 to 6 months by which time ground level is reached and the pit will be found to be full of a fine powdery black compost which is a perfect plant food and suitable for all garden and field manuring.

The advantage of this method is that it suits ordinary garden and field practice and that the heap needs no attention or disturbing once built up, beyond addition of water once a week.

Weeds pulled up each day give one layer—and stable refuse and manure collected during the same day give another. Where there are large accumulations of weeds and manure complete compost heaps can be built up at once—otherwise they can be built up gradually.

The following are done in one operation:

(1) Manufacture of the finest possible manure.

(2) Elimination of weeds and, therefore, improvement of crops and pasture, or gardens.

(3) Clearing of ditches, drains, stagnant pools, etc.

(4) Reduction of mosquitoes (*vide 3 above*) and improvement of sanitary conditions generally.

(5) Full utilization of cowdung, stable refuse, urine earth and other animal manurial products.

Manure, instead of being scattered in a dried-up state on fields to be largely blown away in the hot weather, or collected in offensive piles round houses to breed flies and generate disease, can, by this method, be combined with organic waste and rapidly converted to something possessing more lasting value than artificial fertilizers and having an immediately beneficial effect on crops or gardens

The value of green weeds is derived from their containing all the valuable material of the plants. Cell sap and living cell contents are obtained. Dead leaves and cut plants which have flowered and died are cellulose skeletons only—the material of the cell contents having been withdrawn into the tissues of the stem or into the roots. They are, of course, far better than nothing and should always be utilised and not neglected—particularly where the supply of stable manure is inadequate. The point, however, to remember is that there is no substitute for green material in this method. Uprooting of living green plants is, therefore, necessary to get the full benefit of the process and the rains months are obviously the best period in which to do this.

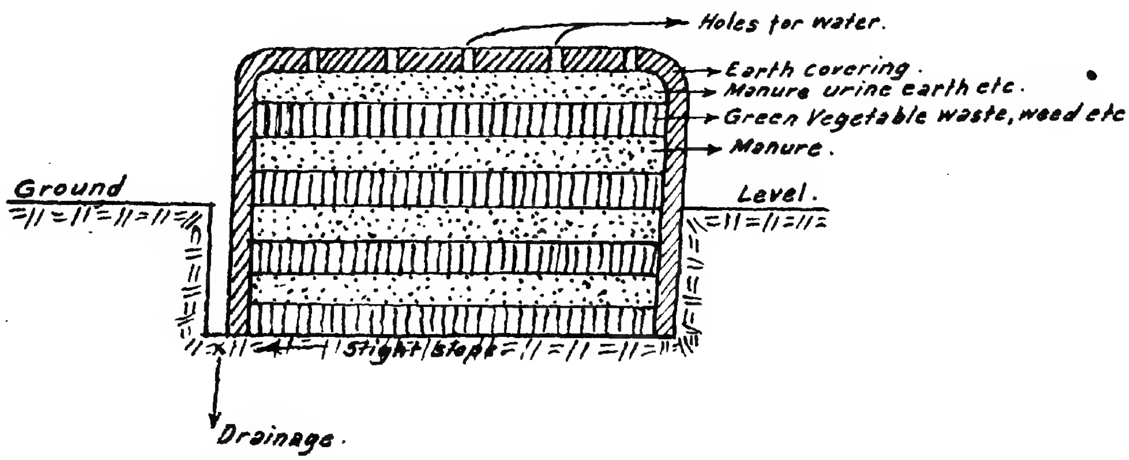
Green material packed tightly in the heap renders fermentation rapid and complete. It contains its own moisture. The thorough soaking of every alternate (*i.e.* manure) layer when the heap is prepared will give all the liquid required during the process of making the heap. If the heap does not get hot and commence subsiding and does not continue to stay hot and gradually subside then there is either too much water in the pit or too little in the heap. It is thus quite easy to check progress by observing the state of the heap from time to time.

The hottest place in the heap is in the centre. Large sticks and green wood branches can be best broken down into compost if they are placed in the middle of each layer. Hedge clippings and any other similar green vegetable material can be broken down to compost conveniently in these heaps. If sawdust is used, a thin sprinkling only on each layer is all that should be added.

It should be noted that this method is not suited to utilisation of night soil. The best thing to do with night soil is to fill it into trenches 4 feet deep. When 2 feet of night soil has been accumulated, fill in the trenches with 2 feet of earth and leave *them alone for one complete year.* Then plough up in the ordinary way over them and sow crops.

The above notes are not technical and contain nothing original. They are merely a practical description of the simplest of all methods of preparing compost requiring the commonest ingredients and the most elementary form of attention. It has been used successfully for many years at Chikalda in Berar by Brother Eugen Oppold of the R. C. Mission who demonstrated it to the writer.

There are various other methods of composting, requiring frequent turning over of the heap and addition of other ingredients but nothing could be simpler or more effective than this one. Any compound or any village can be improved by composting waste material and to-day when artificial and in fact all forms of manure for fields are in demand it is essential that some such simple system should be used widely.



I understand that in Germany the compost heap is called—"Der schatz des gærtnes" or "The Buried Treasure Chest of the garden."

A suitable name in Hindustani may, therefore, be *Bagh ki daulat*—'बाग़ की दौलत'

TEAK PLANTATIONS IN MYSORE AND THEIR SITE QUALITY

By Krishnaswamy Kadambi, D.Sc., Dip. in Forestry (Munich),

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In less than a decade after Conolly, Collector of Malabar, started his famous teak plantations at Nilambur, the earliest teak plantation in Mysore was founded on the bank of the river Tunga near Sakrebyle, a village about 8 miles from Shimoga on the Shimoga-Mangalore trunk road. It is generally stated that the officer at whose instance this plantation was formed had visited Nilambur before and seen, for himself, the remarkable success of the plantations there, and this knowledge must have led him to select the bank of a river as the most suitable 'site' for his first plantation. The planting operations became thereafter a regular annual event for about a score of years, and whatever has survived till to-day of this old time planting extends along the river bank as a narrow strip over a distance of about two miles and covers an area of about 300 acres. Curiously enough the oldest plantations in Mysore were formed through the enthusiasm of a medical officer. A number of these oldest plantations seem to have failed and some have almost entirely disappeared but their position is indicated by the dated slabs of granite which still stand erect--mute witnesses to that novel activity less than a century ago. The most successful remnant among this series of plantations, known as the KANIVE plantation, is now

85 years old and has trees averaging 5 feet $7\frac{1}{2}$ inches girth and 98 feet 3 inches height.

Not long after the Sakrebyle plantations were formed, one Oswald, Deputy Commissioner of Kadur district, started in 1862-63 his series of plantations near Lakkavalli village, also along the bank of a river—the Bhadra. The most successful remnant of Oswald's series of plantations now bears his name and covers 23 acres: here the trees have reached a girth of nearly 5 feet 6 inches, but are somewhat more defective than those of the Kanive plantation.

In the year 1870 teak planting was started in a third locality also along the bank of a river—the Somavahini—near the village Hebbe, later the headquarters of a well-known forest range which now bears its name. The Somavahini teak plantation (5 ac.) is the best known of this group.

A portion of the area regenerated with teak at Sakrebyle and Lakkavalli seems to have failed owing to faulty selection of 'site' for teak. Guided by the successful results of Nilambur it was, presumably, believed by those early men in this field that proximity to a river would guarantee success of planting. They did not notice, even after some failures, that the level of the sub-soil water rises abnormally during the rainy season in many such localities causing swampy conditions and that teak is very intolerant of such a situation.

Between 1873 and 1876 almost the first teak plantations for Mysore district were founded at the southern end of the State near a place called Kakankote, now the headquarters of a forest range: *but these were not made on the bank of a river.* They cover an area of about 112 acres, and should be looked upon as the most successful of the very early plantations because *in no portion of the area did the planted teak fail.* The trees here average nearly 4 feet 8 inches in girth and 82 feet in height.

The notion that proximity to running water is the criterion for the successful regeneration of teak prevailed, however, till the end of the last century, and one finds the plantations then formed mostly adjoining rivers of major streams. The plantations along the Kabini river—the Manchegowdanhalli plantation of 100 acres (The forest lodge plantation 1887-88), the Peel-khana plantation at Udbur-kadu of 20 acres (1890-91), the Mastigudi old plantation, the Khedda-store and other plantations opposite the Kakankote bungalow, the Kapila group of plantations of 105 acres near Begur (1891—93)—are all successful examples. Teak has disappeared altogether from a portion of the area then planted up, having been replaced by the Big Bamboo (*Bambusa arundinacea*) owing to indifferent soil drainage, but that which has remained contains some of the best bits of artificially regenerated teak forest we have in Mysore to-day. Many of these plantations were formed under the guidance of Colonels Ricketts, Pigot and Campbell Walker, then Inspectors-General of Forests in Mysore.

With the turning of the century the need for and the value of teak plantations began to be fully appreciated. The silvicultural demands of teak then began to be studied in more detail, and the influence of soil drainage on teak growth was soon realised. The old idea that proximity to running water is an essential factor for the success of a plantation was given up and plantation 'sites' were selected all over wherever the drainage and soil were found suitable. A great many successful plantations were raised during the early years of this century under the guidance of the Conservators M. Muthanna, R.B. and M. G. Ramarao. The first world war and the subsequent timber boom gave a further impetus to teak planting activity, and a long-term policy was then laid down by the head of the Forest Department, Mr. B. V. Ramiengar, for converting units of natural forest in most suitable localities to wholesale plantations. The greater part of Mysore's teak plantations thus dates from the post-war years. In the peak years of teak planting—1932 to 1934—over one thousand acres of plantation was formed annually. The technique of plantation formation was also greatly

improved. 'Stumping' was first introduced in 1930. Nursery technique was developed and much greater attention began to be paid to the selection of suitable localities for planting. True, some mistakes were made with respect to the last but, these were soon corrected by observation and study, thanks to the keenness of the executive staff and the technical guidance of the heads of the Forest Department, so that, almost all the youngest plantations formed under the last two departmental heads (Messrs. M. Machaya and C. Abdul Jabbar) are striking examples of success (*vide Fig. I, Plate 5*). About 15,000 acres of teak plantation have been formed from the beginning of such operations in Mysore (1856) of which about two-thirds the area was covered during the last twenty-five years

In certain respects Mysore's regeneration technique differs from that of the neighbouring British Indian provinces, notably that of Madras. The method of establishing a plantation is more or less the same—clear-felling of the natural forest, burning the debris, and planting of stumps in stake holes after the first, adequately heavy, premonsoon rains—but Mysore's method of early tending and thinning are somewhat different. Two or three weedings in the first year, two in the second and one in the third is generally prescribed here. By weeding is meant 'weed cutting' and not scarp weeding. During this operation valuable species naturally coming up like Rosewood, *Pterocarpus marsupium*, etc., are generally left uncut. After the third or fourth year the plantation is left largely to itself and no cleaning is done unless weeds and undesirable inferior species or bamboo are actually in the act of overtopping the planted teak. The date of the first thinning is postponed to the 8th or 10th year or generally even later, and this is guided solely by the requirements of the crop (*vide Fig. II, Plate 5*.)

Owing probably to the relatively dry type of forest where teak is grown in Mysore, the variation in the method of early tending and weeding and the practice of delaying the first thinning the rate of height growth of plantation teak is relatively small in the earlier years, compared to that indicated for the All-India Standard site qualities on the same quality of soil. The comparative figures are given in the *Table on page 61*. The figures of the rate of growth of teak for Mysore plantations were worked out by the writer on crops from the very best to the very worst in Mysore. The plantations on which the data have been based are known to have received generally uniform treatment (except probably a few of the old ones in which a certain amount of pruning has been done) namely, weed cutting in the first three or four years, a cleaning, if required between about the fifth and eight years and thinnings as and when required starting from the tenth year or later. The Mysore site qualities I, II and III shown in the above figures correspond roughly to site qualities III/IV, IV and V respectively of the All-India classification. The very best plantations of Mysore approach site quality III of All-India. From the table it is also seen that in the first twenty years the height growth of Mysore plantations is far behind the All-India standard, quality for quality, for the two site classes III/IV (Mysore I) and IV (Mysore II) while site class V of All-India is superior to site class III of Mysore throughout.

The charges commonly levelled against pure teak plantations do not generally apply to those of Mysore. These common charges are examined below:

(1) There is reported to be a general falling off in the rate of growth and in health of a pure teak plantation after 10 to 20 years.

This impression is probably illusive and has been created by the general faster growth of a uniform crop early in its life compared to an irregular crop. Pure teak plantations are also said to fall off in health probably because their rate of height growth slackens after 10 to 20 years. The height growth of Mysore teak plantations is comparatively less in the early years but lasts for a longer time in their life, up to 25 years or more.

Fig. I

A portion of the teak plantation near Arasalu, Shimoga District, of 1931, one of the most successful of its kind.

Photo: Author· December, 1938

Fig. II

A portion of the teak plantation of 1929 in Malandur S. F. (Shimoga District) which has remained unthinned since its formation. Observe the dense natural undergrowth whose retention is expected to prevent the alleged deterioration of the soil under pure teak.

Photo. Autnor: June, 1938.

TABLE (*vide page 60*)

Age in Years	Top Height in Feet						Number of Stems per Acre					
	A		*B*		*C*		*A*		*B*		*C*	
	Mysore I	India III/IV	Mysore II	India IV	Mysore III	India V	Mysore I	India III/IV	Mysore II	India IV	Mysore III	India V
1	2	3	4	5	6	7	8	9	10	11	12	13
10 ..	38	44	28	39	24	29	450	384	772	450	882	772
20 ..	58	58	51	51	34	38	248	207	400	255	582	472
30 ..	67	66	63	59	40	44	156	138	217	172	353	304
40 ..	74	73	69	64	45	48	112	105	145	130	252	233
50 ..	80	78	72	69	49	52	88	85	111	106	202	194
60 ..	84	82	75	73	53	55	71	70	89	86	171	168
70 ..	88	86	78	77	56	58	58	58	73	72	147	146
80 ..	92	90	80	80	58	60	48	48	59	59	125	125
90 ..	93	93	82	83	59	62	44	..	55	..	117	..
100 ..	95	97	84	86	60	64	40	..	52	..	110	..

(2) It is suggested that there may be deterioration of soil under pure teak and lowering of growth quality.

The plantations are mostly in the first rotation for teak in Mysore and no soil deterioration has so far been noticed, probably because much of the harmless underwood and undergrowth which come up naturally in our teak plantations is left intact.

(3) It is complained of that soil erosion in pure teak plantations is more serious than in natural forest.

No erosion has been observed in any of our plantations owing probably to the existence of the natural undergrowth and the efficient fire protection.

(4) Fluting of boles is said to be more prevalent in pure teak plantation than in natural forest.

There is little difference between natural forest teak boles and the teak boles in our plantations as regards amount of fluting. But the latter are appreciably taller, less eccentric in cross section and less branchy.

(5) Epicormic branches are said to be more abundant in plantations and to cause knottiness in timber.

These branches do not generally persist on the lower portion of teak boles in Mysore plantations, and even in the upper portion they rarely grow into large side branches. In plantations which have not been successfully protected from fire epicormic branches are more conspicuous, and have probably contributed to increase the branchiness of the bole.

(6) Defoliation and damage by insects and parasites are said to be worse in plantations.

There is a certain amount of defoliation in Mysore teak plantations which could be called 'serious' in some years but, in such years, trees in the surrounding natural forest are not seen to suffer appreciably less than those in plantations. Damage by insects is not so serious owing probably to the presence of alternative food plants in the natural undergrowth of our plantations.

7. Regeneration in pure teak plantations is said to be more difficult owing to inadequate burning material and possibly soil changes.

The second rotation for teak planting has not yet started in Mysore, but under our conditions there ought to be no great difficulty in finding adequate burning material in the abundant undergrowth which generally exists in plantations. With early stump planting and suitable cultural operations no difficulty need be anticipated in this connection.

8. Plantation teak is said to be inferior to natural forest teak in strength, durability, texture and working qualities and to fetch, therefore, lower prices.

Plantation teak has not been reported to have fetched less price than natural forest teak in any timber sale in Mysore, nor has it (plantation teak) suffered in repute either on account of alleged inferior timber quality or other drawbacks enumerated above. It is not improbable that this is due to the difference in the treatment the plantations here receive, namely, the postponement of the date of first thinnings, the maintenance of a denser stand and the retention of a considerable portion of the undergrowth which naturally comes up in plantations.

The first visible result of this treatment is the appreciable meagreness, of the rate of growth of teak in first decade or two of a plantation's life compared to British Indian standards, which involves sacrifice of increment. The main object of management in Mysore is to grow clean timber of good quality, and it is therefore probably correct to maintain a relatively denser stand and thus obtain a moderate but fairly uniform rate of growth during the youth of a plantation. To one who sees the Mysore plantations after his visit to Nilambur, these appear to be badly in need of cultural operations but Mysore's method of early treatment is different and it probably serves the object of management here better.

SOFTWOOD DISTILLATION IN CANADA AND INDIA

By Rai Sahib T. P. Ghose
(Forest Research Institute, Dehra Dun)

Distillation of pine and other resinous softwoods is carried out chiefly for tar and charcoal, the aqueous condensates, commonly known as pyroligneous liquor, being poor in methyl alcohol, acetic acid, acetone, etc., is not worked up for these products, as is done in the case of pyroligneous liquors from hardwood distillation. Formerly when the retort process of distillation, or the colossal bee-hive masonry kilns of United States of America had not been developed, highly resinous softwood used to be carbonized in small earth-covered kilns with a sloping floor, along which the heavy tar used to flow down into a receiver and much of the vapours of the lighter tar oils used to escape from the side or top openings of the kilns. This process was extensively in use in Scandinavia and the heavy tar, that used to be marketed, went by the name of Stockholm tar. It was a thick viscous substance of a granular structure. It used to find application in caulking of boats, painting of marine ropes and to a small extent in medicine. With the introduction of the retort process of distillation, in which all the vapours formed during the carbonization of wood are condensed together by means of water-cooled condensers, the tar produced is much thinner in consistency, because it contains all the terpenes and lighter tar oils. This thin primary tar is, therefore, redistilled and the bulk of the turpentine and lighter tar oils are removed. The residual tar is fairly thick in consistency and goes by the name of Pine Tar. This tar, which has now replaced Stockholm tar, besides being used for the same purposes as Stockholm tar, is now used principally as a plasticizer in the manufacture of rubber tyres. Amongst the other uses of pine tar, mention may be made of the impregnation of hemp fibre, in the production of oakum, of the painting of ropes and cordage and of it's use, to a limited extent, in soap and pharmaceutical preparations.

The light oils recovered during the redistillation of the primary retort tar, also find important industrial application. It yields wood turpentine (as distinguished from the spirit of turpentine obtained by steam-distillation of the oleo-resin) and pine oil. The former, although inferior to the spirit of turpentine, finds application in the paint and varnish industry as a cheaper solvent. Pine oil, on the other hand, is an important economic product, being much in demand for ore-floatation purposes. It also finds application in the textile industry, as an emulsifying agent, as a solvent of resins and for many other purposes.

Prior to the present war, countries bordering on the Baltic Sea and United States of America were the chief producers of pine tar and associated products, and used to meet the demand of Great Britain, Canada, India and other countries. During the present war, supplies from the other European countries having been practically cut-off, U.S.A. remained the only source of supply of these products to Great Britain, Canada and India. Apart from the fact that U.S.A. could not possibly meet the full demand of pine tar from all the allied countries, there was another cause which accentuated the shortage of supply. For several years prior to the war the production of pine tar in America had steadily decreased, because America had taken more and more to the extraction of highly resinous old stump wood with the newly developed 'steam and solvent' process, which yielded turpentine, pine oil and resins such as calophony and vinsol resins. The residue on destructive distillation does not yield pine tar.

The shortage of supply of pine tar in England and Canada led to an investigation being taken up in the Forest Products Laboratories of Canada regarding the possibility of developing a source of supply of pine tar in Canada. The result of these investigations

are embodied in a note "Production of Pine Tar by Destructive Distillation of Canadian Softwoods" by H. Schwartz and C. Greaves (1944). Prior to the present war, it was generally held that Canada could not compete with the U.S.A. in the pine tar market for the following reasons: (1) average resin content of the Canadian species like Douglas fir, Western yellow pine and red pine, was lower than the pines of the Southern United States, (2) highly resinous wood had to be carefully selected for purposes of distillation to give commercially profitable yields and (3) the cost of collecting the raw material was high. According to Benson, Thomas and Wilson (Chemical Utilisation of Wood in Washington, University of Washington, Engineering Experiment Station, Bull. No. 19, 1923), "the only material feasible for use on a commercial basis is selected mill waste with a high resin content, which material is about 13 per cent. of the common run mill waste."

The present shortage of supply and high prices of pine tar has made it possible to overlook the economic aspect and to make a start with the development of the industry. The result of the detailed investigations reported by Schwartz and Greaves show that yield of tar from distillation on a commercial scale of selected resinous Douglas fir mill waste was satisfactory and that from white pine was low. It has, however, been suggested that the yield could be increased by improvement in the method of distillation. The pine tar obtained from these species was quite suitable as plasticizer for the rubber tyre industry. The pine oil obtained as a by product could be used for ore floatation purpose. Thus there is a fair prospect for the softwood distillation in Canada.

In India, the shortage of supply of pine tar, on account of the present war, presented an identical problem regarding developing ways and means to meet the country's demand for this product. This problem, however, was not quite as new as in Canada. During the World War No. 1 there was an acute shortage of the then commonly used product, Stockholm tar. The United Provinces Forest Department, in collaboration with the Forest Research Institute, produced a tar, similar in properties to the imported tar, from the highly resinous stump and root wood of the chir pine (*Pinus longifolia*). This tar was produced by a modified kiln process which consisted in heating the wood, encased in a cylindrical iron casing, made of thin steel sheet, all round in a masonry furnace and collecting the condensed heavy tar from the funnel-shaped bottom of the kiln. Much of the turpentine and light tar oil vapours used to escape from the loosely fitting lid of the iron kiln and its central aperture. The heavy tar collected from the bottom was thick, viscous and treacle like substance. It met the war-time requirements of Stockholm tar of this country. The industry flourished during the war, when prices were high, but soon after the war it had to be closed down because it failed to compete in price with the imported tar

The present war having once again cut off supplies of softwood tar, efforts were made by the United Provinces Forest Department to re-start the chir tar industry. But, when the heavy chir tar, produced by the old modified kiln process, was submitted to the consumers for trial, it was found that this tar could no longer meet the present-day requirements. The redistilled pine tar had replaced the old Stockholm tar during the period intervening between the two wars. Newer uses having been found for it, such as its use in the rubber tyre industry, newer specifications had been laid down for the required softwood tar. It was, therefore, clear that the chir tar industry had to be recast to produce a tar conforming to the present-day specifications.

This problem was taken up for investigation at the Forest Research Institute, Dehra Dun. Efforts were first made to recondition the heavy tar prepared by the old modified kiln process to suit the present-day requirements. The chief defect of this tar was that it contained very little of the lighter oils and it contained a certain amount of exuded undecomposed resin, and imparted to it the stickyness objected to by the principa

consumers of soft wood tar, like the rope works and the rubber works. Furthermore, this process was wasteful in so far as much of the vapours of the lighter tar oils used to escape un-condensed. These could, however, be condensed by attaching a swan neck to the top aperture of the kiln and connecting it to a water-cooled condenser. With this improvement to the kiln two products could be obtained, a heavy tar collected, as before, from the bottom of the kiln and a light tar oil collected from the condenser. It was found possible, by giving suitable treatment to both the heavy tar and the light tar oils, to produce pine tar of the required specification. But, since the old modified kiln fitted with a water-cooled condenser would virtually be a retort and would still be wasteful to some extent, in as much that some tar vapours would escape from the bottom aperture, through which the heavy tar would be collected, it was decided to scrap the old kiln process and to replace it by the more modern retort process of distillation.

The old modified kilns had certain advantages. These were easy to construct and cheap in cost. Moreover, these were light and easy to transport. These were important considerations to be borne in mind in developing the retort process of distillation. Conditions in India are different from what they are in Canada. In India *Pinus longifolia* or chir pine occurs at high altitudes in hill forests, where well-constructed roads are lacking. Distillation of chir pine wood cannot, therefore, be carried out in a central factory, on account of transport difficulties and high transport charges. Furthermore, it is only the highly resinous old stump and root wood that has to be distilled to get a remunerative yield of tar. Thus distillation has to be carried out on the spot, where such wood is available in quantity and the site has to be shifted whenever supply in a particular area gets exhausted. For the above reasons distillation of chir pine can only be carried out on a small scale in light and easily portable plants. Several light retorts, each capable of holding a charge of 400 to 500 lbs. of wood were, accordingly, constructed and set up in different areas of the hill forest of the United Provinces. These units are producing the primary tar, which is being worked up into pine tar and associated products in the factory of the Turpentine Subsidiary Industries Ltd., P.O. Clutterbuckganj, Bareilly.

The investigations carried out by Schwartz and Greaves in Canada were of an exploratory character and were intended to collect data regarding the yield and quality of the primary tar obtainable from different Canadian softwood species and, since mill waste was to be their raw material, they studied the relationship between the resin content of such wood and the yield of tar. They also studied the treatment that will have to be given to the primary tar in order to produce pine tar and pine oil of the proper specification. The distillations were carried out on a laboratory scale in a small retort, under properly controlled conditions. The result of laboratory scale trials were compared with those obtained from large scale distillations carried out in a hardwood distillation plant. Some of the results of these trials, for the two principal softwood species, *viz.*, Douglas fir and white pine, are given below:

RESIN CONTENT AND YIELD OF TAR

Description	Resin content of wood per cent.	Yield of tar, on wood per cent.	Yield of primary tar, per cord,* in lbs.
Douglas fir heart wood	1.14	7.1	199
Douglas fir selected resinous mill waste ..	62.5	47.8	2,470
White pine, selected resinous mill waste ..	39.0	46.4	1,665

* One cord of wood contains 9 cu. ft. of solid wood.

The conclusion arrived at was that the higher the resin content of the wood the greater the yield of tar.

In the following table the yield of tar from average consignments of Douglas fir and white pine mill waste, both in the laboratory scale and large scale trials are given. For the laboratory scale trials the consignments were divided into resinous, medium and poor classes, by visual inspection.

Description of wood	Scale of distillation.	Average sp. gravity of wood	Yield of primary tar (on dry wood) *per cent.*	Yield of primary tar per cord. *lbs.*
1. Douglas fir 1st consignment .. .	Laboratory scale.	0.83	37.4	1,735
2. Douglas fir 2nd consignment ..	Do.	0.655	30.0	1,100
3. Douglas fir 3rd consignment	Do.	0.595	18.0	600
4. Douglas fir mill waste (Average of the consignments) .. .	Large scale	..	..	743
5. White pine highly resinous mill waste (58 *per cent. of the consignment*) ..	*Laboratory scale.*	*0.596*	*40.4*	*1,349*
6. White pine, medium resinous mill waste, (24 per cent. of the consignment) ..	Do.	0.540	31.0	936
7. White pine, mill waste poor in resin (18 per cent. of the consignment) ..	Do.	0.465	25.0	651
8. White pine mill waste average of the consignment	Large scale.	..	..	478

The above results clearly indicate that in Canada the selected resinous mill waste would constitute a fairly good raw material for the production of softwood tar. It has been estimated that from the mill wastes of Douglas fir and white pine about 230,000 gallons of primary tar per year could be obtained and this quantity would meet 65 per cent. of the country's demand.

The primary tar from these Canadian species was thin in consistency and to prepare pine tar of the proper consistency about 25—35 per cent. of the light oils had to be removed by redistillation. The temperature up to which the distillation was carried varied from 165°C. to 180°C. The residual tar constituted the finished pine tar. It conformed to the specifications of the commercial product and was pronounced satisfactory by the rubber tyre industry, after actual trial. The removed light oils, on rectification, yielded pine oil, boiling between 180°—245° C., which was also found satisfactory for ore floatation purpose.

In India, it was already known, from previous experience, that the resinous old stump and root wood of chir pine gave the best yield of tar and consequently it is this type of wood that has so far been used for purposes of distillation. Experimental distillation of resinous as well as lean slash wood gave much poorer yield of tar and confirmed the above view.

The problem of meeting the war-time demand of the country for pine tar being very pressing and it having been decided that closed retorts are to be used for distillation, attention was directed to the study of the properties of the primary tar produced by this process and to determine the treatment that should be given to it to produce pine tar. After a series of trials it was found that

the primary tar, which was thin in consistency and low in viscosity, should be re-distilled to a temperature of 250 C., to remove the light oils and to further decompose the resinous constituents. Since the residual tar was too thick and viscous, it was necessary to add back about 10—12 per cent. of the light oils, to give to it the required thickness and viscosity. The finished product, thus obtained, conformed to all the specifications for the imported pine tar. Actual trials by the consumers like the rope-works and the rubber-works showed it to be entirely satisfactory.

The light oils, that were removed from the primary tar by redistillation, were given a different treatment. It had previously been observed (GHOSE, T. P., 1919. *Light Chir Tar Oil. Indian Forester.* 45 (2): pp. 112—117) that the light chir tar oils prepared by the old kilns process contained a fair amount of phenols. The primary retort tar on being examined was found to contain 5—6 per cent. of phenolic bodies, and from these crude phenols 35—40 per cent. of wood creosote B.P. could be obtained. Most of the phenols are present in the above mentioned light oils It was thus shown that wood creosote B.P. could be produced from chir pine tar to meet the country's demand for this medicinal product of which there is an acute shortage on account of the war. Full details regarding preparation of wood creosote B.P. and other medicinal products from chir pine tar have already been published (GHOSE, T. P. and VARMA, B. S., 1942. Medicinal Products from *Pinus longifolia Tar. Ind. For. Leaflet* No. 12 (*Chemistry*). The light oils were, accordingly, extracted with caustic soda solution to remove the creosote. The creosote-free light oils on being fractionated yielded (*i*) 55—65 per cent. of wood turpentine boiling below 185°C. and (*ii*) 13—18 per cent. of pine oil boiling between 185°—240°C. The average pine oil from chir tar had the following properties: density at 15.5°C. = 0.926; refractive index at 15.5°C. = 1.4865.

The light oils from the tars of the Canadian softwood species contain less of the wood turpentine and more or less the same percentage of pine oil. According to Schwartz and Greaves, the light oils from Douglas fir tar contain 16.4 per cent. of wood turpentine boiling below 190°C. and 13.8 per cent. of pine oil boiling between 190°—245 C.

In the following table, the yield of the primary tar, the finished pine tar and the light oils obtained from *chir* pine have been compared with those obtained from the principal Canadian softwood species. These results are from large scale distillations.

Name of species	Yield of primary tar, on wood, per cent.	Yield of finished pine tar, on wood, per cent.	Yield of light oils from primary tar, on wood per cent.
1. *Chilka* or resinous old stump and root-wood of Indian *chir* pine ..	30.9	16.5(2)	5.9(4)
2. Resinous slashwood of *chir* pine ..	18.6	10.7(3)	3.3(4)
3. Poor slashwood of *chir* pine ..	4.1	..	..
4. Resinous mill waste of Canadian Douglas fir	20.2(1)	13.7	6.5
5 Resinous mill waste of Canadian white pine	15.4(1)	10.0	5.4

1. Calculated from figures given by Schwartz and Greaves, taking a cord of wood to be 90 cu. ft. and the average density of Douglas fir to be 0.65 and that of white pine to be 0.55.

2. The yield of pine tar was 55 per cent. of the primary tar.

3. The yield of pine tar was 57 per cent. of the primary tar.

4. Balance of light oils, after adding back the requisite quantity to the residual tar obtained by redistillation of the primary tar, in order to convert it into pine tar.

The following table shows the properties of the finished pine tar prepared from the primary tars obtained by distilling resinous Indian *chir* pine and Canadian Douglas fir and white pine wood.

Properties	Finished pine-tar from resinous stump of *chir* pine	Finished pine-tar from resinous slashwood of *chir* pine	Finished pine-tar from selected resinous Douglas fir mill waste.	Finished pine-tar from selected resinous white-pine mill waste.
Density ..	1.043 (15°C.)	1.049 (15°C.)	1.006 (23°C.)	0.999 (23°C.)
Water content (per cent.) ..	0.4	Trace	Trace	Trace
Acid content (as acetic acid, per cent.) ..	..	..	0.17	..
Viscosity ..	5.2 minutes (Engler at 75°C.)	4.3 minutes (Engler at 75°C.)	4.33 minutes (Red wood at 36°C.)	2.33 minutes (Red wood at 36°C.)
Solubility in 95 per cent. alcohol ..	Soluble.	Soluble.	Soluble.	Soluble.
Oils distilling below 285°C. per cent. ..	10.1	..	27.5	26.4

From the above results it will be evident that the old stump and root wood of *chir* pine gives better yield of both the primary tar and the finished pine tar, than what can be obtained from resinous mill waste of Canadian softwood species. Even the resinous slash wood of *chir* pine gives better yield of these products than the resinous mill waste of Canadian white pine. The pine tar industry in Canada is yet in the formative stage, whereas this industry is now fairly well established in this country and is meeting the present demand for pine tar and associated products. It has the additional advantage of yielding by-products like wood creosote B.P. and other pharmaceutical preparations of soft wood tar-like 'pix liquida,' 'oleum picis,' etc. If, as would appear from the note by Schwartz and Greaves, the prospects of establishing a pine tar industry in Canada is fair, there is no reason why the already established *chir* pine tar industry in India should not flourish in normal times and face competition from imported foreign products. It would indeed be a pity if this industry, re-established through the exigencies of the present war, is once again wiped out on economic grounds. It should, therefore, be the earnest effort of all connected with the management of this industry, to see that it is placed on a sound economic basis, so as to be able to survive in normal times.

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SPECIES FOR DRY AREAS

BY J. SMITH

(Chief Conservator of Forests, Anglo-Egyptian Sudan)

FOREWORD

This article was sent to me by Mr. Smith as an ordinary letter and was not written or corrected for publication. It was so interesting to me at any rate that I am publishing it with Mr. Smith's permission.

S. HOWARD,

Inspector-General of Forests, India.

R. E. Massey introduced a mesquite about 1919 which "escaped" quite rapidly at Shambat near Khartoum in about 6 inches of rainfall. It is spread by goats.

This is believed to be *Prosopis juliflora D.C.,* Argentine form (*see* N. P. Mohan, *Punjab Forest Records,* Vol. I, No. 9). There is a good deal of variation, though not in the pods which are remarkably true to N. P. Mohan's Types 4 and 6. It has been tried across the 3 to 20 inches rainfall range with very varied results. The best results are at Khartoum in 6 inches average rainfall on a low dune first formed when wind-rolled sand was trapped by *Calotropis procera.* The surface sand of this dune, owing to wind-removal of fine particles, is very coarse. Rain penetrates rapidly. The skin formed by rainfall on many dunes does not readily form on this dune, and there is very little runoff. The species has grown only moderately well on the bright-red sands of Kordofan and Darfur, even with 14 inches rainfall. Better results are obtained on newly-accumulated sand, apparently because of better penetration of rain. Around Khartoum moisture is retained in newly accumulated dunes throughout the dry season and the right type of sand is still moist enough, four feet down, to cohere when pressed in the hand in June at the end of the dry season.

Plants are raised in removable tins 10 inches by 2 inches diameter. In the nursery they are cut back repeatedly to about one foot of stem and toughened, by exposure and light watering, to help them to resist attrition by wind-moved sand after planting out. They are planted any time after rain has penetrated to a depth of twelve inches. But if subsequent rains fail to carry the season's moisture down far enough to effect a junction with the moisture of the previous season at four feet, failure is inevitable. Little is to be gained by early planting and some of the best results were planted following a heavy October rain, the best precipitation of that season.

The species has not succeeded under rainfall on cracking clays. This failure on clays was most pronounced on clays weathered direct from basalts. Even twenty-four inches of rainfall do not enable mesquite to grow on these soils. On 70 per cent clays in the Gezira plain (natural vegetation *Salvodora persica,* water table 30 feet and *not* rising with continual irrigation, rainfall 10 inches, no success, but when established by unridged irrigation for one season the species survived thereafter by rainfall only, though not thriving. In the 6-inch rainfall the clay plains do not swell sufficiently to crack on drying. They show "fossil" cracks dating from wetter conditions and now sand-filled.

A thin surface layer of sand and calcium nodules and dust overlies the true clays and (except the nodules) is moved seasonably by wind, mostly in June. A fence can accumulate four feet deposit in a windy year and half that depth when May and June have few winds. The mesquite thrives on these newly-accumulated ridges and the roots are capable of bridging the junction of the sand and the underlying clay. There have been several failures on dunes for which there was no obvious reason.

Mechanical analysis of success and failures on sand were carried out. The first result was as follows: ,

"Your sample number	..	1	2	3	4	5	6	7
Our sample number	..	12,050	51	52	53	54	55	56
Tree growth	..	good	bad	poor	good	good	bad	bad
Stones and Gravel per cent.	..	0	0	1	0	0	0	1
Coarse sand per cent.	..	68	59	52	63	55	87	83
Fine sand per cent.	..	26	33	34	28	38	9	14
Silt per cent.	..	1	1	6	2	1	1	1
Clay per cent.	..	5	6	7	8	6	3	3
Salts per cent.	..	.02	.02	.03	.02	.03	.01	.01
Alkalinity (pH)	..	9.3	9.2	9.7	9.2	9.5	9.1	9.2
Cap. Rise (mm in 5 hrs.)	..	183	207	248	269	224	241	211
$CaCO_3$ in coarse fraction	..	some	some	much	some	nil	nil	trace."

I asked for a further subdivision of the sand fraction and the second result was as follows:

"Your sample number	..	1	2	3	4	5	6	7	8
Our sample number	..	12050	51	52	53	54	55	56	
Tree growth	..	good	bad	poor	good	good	bad	bad	bad
Stores and gravel per cent.	..	0	0	1	0	0	0	1	0
Coarse sand 2—1 mm.	..	13	4	2	14	0	0	1	0
Coarse sand 1—0.5 mm.	..	14	11	3	3	0	0	10	1
Coarse sand 0.5-0.2 mm.	..	48	54	40	51	56	82	59	42
Fine sand	..	20	26	39	24	37	12	23	50
Silt	..	1	1	7	2	1	1	2	1
Clay	..	4	5	8	7	6	4	5	6"

In these analyses Sample 5 is from a dune newly formed of fine sand trapped by a fence. If not planted while still loose and newly formed, sand of this fineness forms a skin under rainfall which produces runoff and planting is subsequently difficult. The samples were all from the surface 6 inches.

Much interesting material has been collected on the clay-*cum*-rainfall requirement of species. The rainfall span (zero to 40 inches) is stretched out over one thousand miles of sands, clays, hills and swamps, their vegetation little disturbed by man. Many apparently anomalous occurrences are explained by what I have called "The clay-water line" of the species.

I attach six plates* from a paper, "The clay-water relation" which I wrote in 1939, but did not publish. The war has prevented completion, but I have now a much fuller range of records, all helping in the interpretation of the water value of sites and complementarily of the water requirement of species on sites of known mechanical analysis. The older I grow the more clearly do I realise that no tree is an indicator of any one factor save under the most restricted conditions governing the other factors. Two complementary factors in my opinion are rainfall and the mechanical condition represented by the degree of fragmentation of the surface soil. The species here are highly versatile in the rainfall demand and in soil condition taken

*Owing to the cost of illustrations it has not been possible to reproduce the plates. The information tabulated on page 87 was, however, obtained from the graphs and it is hoped that this method of presentation will not seriously affect its value.—*Ed.*

separately. They are the reverse of versatile in the dual particle size—rainfall factor. That is why it is necessary to choose sand dunes to grow mesquite in low rainfall.

Species.	Clay per cent.	Rainfall mm.	Rainfall inches	Remarks.
Khaya senegalensis ..	12.3	420	16.5	Plantation.
(*Acacia Juss*) ..	39.8	760	29.9	Do.
Sudan Mahogany ..	56.6	1050	39.6	Natural.
	65.0	1500(*a*)	59.1	Plantation (*a*) Irrigation.
		300(*b*)	11.8	(*b*) Rain.
Acacia sayal ..	50.9	600	23.6	
	55.7	480(*c*)	18.9	(*c*) Site believed to be liable to inundation during the rains.
	56.1	575	22.6	
	59.0	670	26.4	
	62.0	650	25.6	
	77.4	720	28.1	
	78.3	760	29.9	
Acacia mellifera ..	23.3	380(*d*)	15.0	(*d*) Sites known to be subject to loss of water by surface runoff.
	39.7	400(*d*)	15.8	
	47.2	400	15.8	
	52.7	575	22.6	
	56.0	575	22.6	
	57.4	420	16.5	
	59.0	570	22.4	
Combretum Hartmannianum. ..	45.0	700	27.6	A broad-leaved pioneer.
	52.0	750	29.5	
	68.0	800	31.5	

Versatility of *Acacia arabica* in terms of clay content only; water supply not determinable owing to dual conditions of rainfall and inundation.

Province.	Range.	Remarks.
Upper Nile ..	54 –73 per cent. of clay ..	Growth decreasing with increased clay content.
Khartoum ..	37– 40 per cent. of clay ..	Do. do.

From distribution records there is only one better site; a rocky hillside though this has not been confirmed with mesquite. A wide range of other species has been tried on sands in 6—10 inches including *neem, Eucalyptus microtheca* and *Hyphæne thebaica*. Success can be achieved provided the plants are hand watered for the first season only, just as mesquite *can* be grown on small-grained dunes, but we concentrated on the search for rainfall sites.

The local species *Acacia tortilis, Ziziphus spinachristi* and *Balanites ægyptiaca* have been neglected on account of slow growth and limited uses but will be used to fill up mesquite failure.

I am about to try out the despised *Parkinsonia aculeata* on some of the most stubborn failure sites. Its ability to tolerate long flooding on very stiff soils points to it as a species worthy of trial on fine-grained dunes, to which, if successful, it would at least give cover.

Forestry has been sorely held up these years and we shall be thankful when we can cease to be ghillies and can look at a tree again without thinking of its cubic contents.

The note is very interesting and provides food for thought though a great deal more data is required before the clay-water relation can be accepted as statistically proved.

It is interesting to remember that in India **Azadirachta indica (neem)** and **Acacia arabica (babul)** occur from Cape Comorin to the Himalayas under very wide conditions of soil and rainfall. Some of India's finest **babul** occurs on black cotton soils with a very high clay content in areas of low rainfall.—*Ed.*

ENTOMOLOGICAL NOTES*

BY J. C. M. GARDNER

(Forest Entomologist, F. R. I., Dehra Dun)

10. Insects and Weed Control.

There are in India several species of undesirable weeds that have been introduced accidentally or sometimes intentionally as garden plants and there have been from time to time several enquiries as to the possibilities of using insects to control them. There have been some spectacular cases of success in introducing insects for weed control, as for example of the cactus *Opuntia* in Australia, but also many failures. The search for promising insects means a great deal of exploratory work in the country of origin of the particular weed. The selected insect must have a controlling effect on the weed and must be proved to be harmless to valuable plants and should be able to thrive in its new climatic conditions.

Several years ago I reared adults of the Cerambycid *Nupserha antennata* Gah. (or very near that) from stems of the common weed *Bidens pilosa* in Dehra Dun and in Coorg; more recently I have obtained it from *Siegesbeckia orientalis* in Dehra Dun. The larva tunnels in the soft centre part of the stem and root and may be found in most of the larger and apparently more vigorous plants. At first sight this abundant beetle might appear a promising controlling agent but I doubt if any adverse effect on the weed is of the least consequence since attacked plants produced seeds in profusion.

In 1938-39, Mr. R. C. Mundell was exploring parts of India to find insects suitable for introduction into Australia to control the weed *Xanthium pungens*. He sent me beetles he had raised from this plant and they proved to be the same species that occurs in *Bidens*, namely, *Nupserha antennata*. The only other insect of any importance that he found on *Xanthium* was the Noctuid, *Eublemma rivula*, the larva of which attacks the fruits. Neither species was considered suitable for introduction into Australia.

11. Insects associated with Cryptostegia grandiflora.

This Asclepiad is being planted on a large scale in India and elsewhere for the emergency production of rubber. A paper by Knight (1944, *J. econ. Ent.* *37* : 100), discusses the insects associated with the plant in Haiti. Among these are *Aphis gosspyii* Glover (a cotton pest) which attacks seedlings and young growth of old plants, a scale insect and several species of weevils. Knight remarks that the mouth-parts of the few insects in Haiti that are known to visit the flowers, which are entirely insect-pollinated, are in most cases too short to reach the mechanism.

In India *Aphis gossypii* Glover and *A. nerii* Boyer were recorded from *Cryptostegia* in 1919 (*Proc. 3rd ent. Meeting* *1* : 282, 284). In experimental plantations laid out by the Silviculturist at Dehra Dun plants are attacked by larvæ of *Euplœa core* Cram. (Danaidæ) but early hand-picking prevents much damage being done. This butterfly has been recorded from several species of *Ficus* (Urticaceæ) and from *Nerium odorum* and *Holarrhena antidysenterica*, both Apocynaceæ.

Recently the Silviculturist, U.P., reported considerable mortality among *Cryptostegia* plants grown from cuttings at Haldwani and sent in several specimens. These had all develop strong roots but had died a considerable time before my examination; the wood was completely dry and showed Cerambycid galleries beneath the bark; one larva was present and this I consider to be *Monochamus nivosus* White (Cerambycid); no adults were reared. It is, however, doubtful if this species is anything but a secondary borer in dead or drying stems. Specimens of dead stems sent later showed no evidence of insect attack but the Forest Mycologist reported that fungus was present. The Central Silviculturist suggests that the cuttings were too thick, enabling

* Continued from the *Indian Forester*, Vol LXX, No. 12, dated December, 1944, page 409.

fungus to attack one part (probably the centre of the cut end) while roots were forming elsewhere. His opinion is that smaller cuttings should be used.

The Central Silviculturist tells me that about 3 per cent casualties in the Dehra Dun plantations (raised from transplants) occurred in small weak plants; the apparent explanation is drought in May. Termites attack the dead and dying plants.

12 Borers in Cane.

In December, 1940, the Forest Officer of Lakhimpur Division, Assam, reported serious damage by borers to cut cane (*Calamus tenuis* and *C. latifolius*). The cane is collected and stored by cane *mahaldars* who buy the right to remove cane from a given area; it is of considerable importance for the manufacture of baskets, furniture, etc. The loss due to borer attack was estimated to be 50.000 rupees annually.

The borer concerned proved to be *Dinoderus bifoveolatus* Woll., belonging to the family Bostrychidæ, well-known as causing serious damage to the sapwood of broad-leaved trees and to bamboos. The genus *Dinoderus* contains the worst borers of the last.

It was first suggested (C. F. C. Beeson in correspondence) that control might be effected (1) by prolonged soaking in water or (2) by the liberal distribution of naphthalene in the stores. The first was objected to because the cane lost its red colour (and therefore much of its market value) while the second was expensive and only partially successful.

Bostrychid attack is dependent on sufficient starch being present in the wood tissues; in bamboos the amount of starch (and therefore susceptibility to attack) varies considerably with the season. It seemed probable that analogous variations would occur in cane and Lakhimpur was asked to send monthly samples of freshly-cut cane. These samples were tested for starch by staining with iodine solution. Starch was present in samples cut from March to July inclusive but absent from the others. In the March sample the distribution of starch was very irregular, varying from absent to light. It would appear from these tests that cane cut from April to July (and less certainly in March) is liable to attack.

Since borer attack in cane had not been reported before, Lakhimpur was asked if any change in management had been made recently. The answer, which is significant, was that in previous years cane-cutting stopped in April, but, recently, had been extended to June and July.

It seems to be fairly conclusive that the outbreak was due to the extension of the cutting season from the usual cold weather period (September to April) to later months.

It is stated that *Calamus tenuis* flowers in June and July and fruits about a month afterwards whereas *C. latifolius* flowers and fruits about a month later than *tenius*. The date of mature fruit formation should define the earliest safe-cutting period on the supposition that starch will have been correspondingly depleted.

A report from Nowgong Division, Assam, is to the effect that cane-cutting in that division is limited to the period September April and that no complaints of borer damage have been received.

To sum up, it is highly probable that the normal cutting period (September to April) is the same as the safe-cutting period except that the advisability of including April is doubtful.

COWDUNG ECONOMY

By K. P. Sagreiya, I.F.S.

Summary.—Only a small percentage of the available cowdung is being used as farmyard manure. Large quantities are either not collected or else used as fuel. The main reason for its utilisation as fuel is the non-availability of alternative fuels at cheaper rates, and not the ignorance or the apathy of the people. Under existing conditions when the stock subsists mostly on grazing on poor pastures, the dung must be poorer in nitrogen and phosphorus contents and urine which contains a larger percentage of these nutritive elements must remain unutilised. This points to the necessity of stall-feeding the stock on more nutritive fodder rich in concentrates, such as oil-cakes and pulses, and production of cheaper firewood nearer the hearths. This will be difficult so long as export of charcoal is not restricted and firewood and grass plantations are not created nearer the consuming centres because wood and grass are bulky commodities which cannot be economically transported over long leads. Creation of fodder-**cum**-fuel reserves dotted all over the intensively-cultivated tracts is thus the prime need. Given the necessary facilities and expert help, there is no reason why the agriculturists themselves should not be able to create such plantations and manage them economically on a co-operative basis.

The main difficulty over a large portion of India is to fulfil the legitimate wants of . . . "ordinary village consumers," that is to say, those who at present have no forest land anywhere near them to fulfil their wants. It is this vast number of ordinary villagers who cannot get sufficient forest produce for their minimum needs and of necessity use cowdung as fuel, the whole of which ought to be available for its more legitimate use as manure, which constitutes the most pressing problem in the future forest policy of India. . . . It is still certain that very large quantities of cowdung are burnt which could very easily be replaced by fuel, if it were available.

* * * *

In the Central Provinces, because of the total area of forests in the province and the general distribution of those forests throughout the province practically all the villagers fall under the class of "local village consumers" whose wants are fairly generally and economically supplied.

* * * *

The main problem of any reconstruction scheme for forests and forest policy in India in the post-war era is, however, to supply the wants for small timber and fuel for the majority of the population of India and more especially roughly the northern two-thirds of India. If this problem could be solved, the appalling poverty which exists among the millions of the peasants in India would very largely be removed. Given his supplies of small timber and fuel in his immediate neighbourhood, the fields could be given the easiest and cheapest manure available and a generally increased prosperity would be the result. This is no exaggeration. The general prosperity of India depends largely on the prosperity of the peasants, and this in turn is very largely dependent on having fuel and small timber available in the immediate neighbourhood.

Mixed up with this is the question of grazing. . . . In tackling the problem of the supply of forest produce to the ordinary village consumer provision must be made for grazing.

—SIR HERBERT HOWARD,
Inspector-General of Forests, India, in
"Post-War Forest Policy for India."

As the most terrible and widespread of the human conflicts is drawing to a close at any rate temporarily—the technical experts, as distinct from the politicians, are diverting their attention from production of weapons of destruction to drafting schemes for harnessing the manpower and the resources of the war-weary world to industries conducing to human welfare. To talk of post-war planned economy has thus become the fashion of the day.

Utilisation of all the cowdung produced in India to the best advantage of the nation is, therefore, engaging the serious attention of the Agronomists of the country.

There is one school of thought which is more or less convinced that the use of cowdung as fuel, which appears to be on the increase, is a retrogressive step inasmuch as it can also be turned into farmyard manure which is badly needed for manurial purposes to increase the yield of agricultural crops. It is argued that cowdung is being put to such misuse (*sic*) because the peasantry is ignorant and insular and that this is the prime cause of

the extremely low standard of living obtaining in India. The schemes propounded by these experts, therefore, aim at starting farmyard manure making and distributing centres to demonstrate its utility and to carry on propaganda to educate public opinion and thus "protect the peasantry against its own improvidence." Whenever, in the past, such attempts have failed to demonstrate the advantage of utilising cowdung for manurial purposes over its use as fuel, the failure has been attributed to lack of interest on the part of the "fanatically orthodox" peasantry.

The excerpts quoted at the beginning of this note are a refreshing contrast. Therein it has been conceded that what is compelling the peasantry to use cowdung as fuel is not their apathy nor their ignorance regarding its value as a fertiliser but sheer economic wisdom gained through centuries of trial and error.

Sir Herbert has rightly pointed out that the problem is less acute in the Central Provinces than in the northern two-thirds of India. And yet judging by actual facts even in the Central Provinces it is a major problem because the distribution of woodlands and pastures is far from what it should be to automatically eliminate the use of cowdung as fuel and thus set it free for utilisation as farmyard manure. It is this aspect of the problem that has been elaborated in the paragraphs that follow.

No data are forthcoming of the quantity of excretions of animals available in the Central Provinces for utilisation as manure. A rough estimate is, therefore, made. According to the *Cattle Census Report, 1940*, there were 13.3 million bovine animals, 2.3 million sheep and goats and 0.3 million horses, mules, etc., in the Central Provinces and Berar. The yearly production of excretion utilisable as manure, assuming the daily yield to be 10 lbs. for a bovine or equine animal and 3 lbs. for a goat or sheep works out to nearly 23 million tons (dry weight).

Assuming that nearly half the quantity is lost in the grazing grounds—in fact more than this is wasted so far as the nutritive constituents of the excretion are concerned, because urine, which is rich in nitrogen, is entirely lost, as only a minute percentage of the stock is fed at the stall—and further assuming that nearly 3.5 million tons of cowdung is already being utilised as farmyard manure in tracts adjoining forest where firewood is cheaper, and in the intensively cropped areas where farmyard manuring is a paying proposition, the total quantity which is consumed as fuel would come to nearly 8 million tons a year.*

What is the utility value of this quantity of cowdung as farmyard manure? If 3 tons of cowdung converted into farmyard manure are needed every year to roughly double the crop-yield over a field of one acre, the total quantity available will double the production over 3 million acres, that is to say, over nearly $12\frac{1}{2}$ per cent of the total sown area of the province. Assuming that by such manuring the crop-yield increases by Rs. 25 per acre—a very liberal estimate—the utility value of animal droppings used as manure comes to nearly 75 million rupees. A truly imposing figure, when compared with the gross revenue of the province! And yet if all the dung were so used extra firewood—coal or charcoal is yet a far cry—will be needed.

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* Compare the following data for the whole of India:

"The value of farmyard manure lies not only in the nitrogen but also in the humus that it provides. The total production of cattle manure in India is estimated to amount to 800 million tons a year green weight—equivalent to 160 million tons dry weight or 800,000 tons of nitrogen. Sheep and goats only provide an additional 36,000 tons of nitrogen. Thus even if the whole production of farmyard manure were available, it would not meet the minimum nitrogen requirements of the crops. . . . It has been roughly estimated that 40 per cent. of what is produced is used as manure: aonther 40 per cent. is used as fuel and the remainder is lost due to difficulties of collection. Thus only 320,000 tons of nitrogen from this source are used as manure."

—Memorandum on the **Development of Agriculture and Animal Husbandry in India**, of the Advisory Board of the Imperial Council of Agricultural Research.

What is the cost, landed at the hearth, of an equivalent quantity of firewood? It will not be unreasonable to assume that, weight for weight, an equal quantity will be needed, namely, 8 million tons or roughly 24 million cartloads of firewood. The average lead from the nearest jungle from where firewood is regularly available—and these are few and far between—is roughly 12 miles because firewood cannot bear cart transport for a longer distance than 24 miles. The royalty on one cartload may be assumed to be only eight annas, and the felling, collection and billeting expenses as Re. 1. The transport will cost at least Rs. 4 because, as a rule, the cartmen themselves cut and collect the wood and will thus spend at least two days per trip. Thus the total cost on one cartload of firewood, delivered at the hearth, comes to at least Rs. 5-8-0. In the urban areas the cost is as high as Rs. 8. The money value of 24 million cartloads of firewood will thus be 132 million rupees!

The conclusion is obvious. By utilising dung as manure, and instead burning wood, the agriculturists would lose 67 million rupees!! This is not an exaggerated figure. It may be roughly checked in a simpler way. A cartload of manure sells at Rs. 2 to Rs. 3. For making this at least one cartload of dung is needed. On the other hand, one cartload of firewood cost Rs. 5-8-0. It is thus obvious that the main reason for the use of cowdung as fuel is its comparative cheapness than wood fuel. Is it any wonder then that people who use dung as fuel are very loath to use firewood instead?*

The high cost of firewood is mainly due to the heavy transport expenses. *The obvious remedy is to bring woodlands nearer the hearth.* Ten miles is the outside limit beyond which firewood becomes more expensive than cowdung. Thus even in the Central Provinces with 31 per cent. of its area under forests or scrub and nearly 39 per cent under the plough, the firewood requirements cannot be fulfilled. In other words, so long as villagers do not have their own fuel forests within easy reach, there will be no incentive for using dung as farmyard manure.

Another factor which militates against such use is the high price of charcoal which is being exported in unlimited quantities from the province, to Bombay, Poona and even further afield at costs ranging from Rs. 80 to Rs. 120 per ton. Forest contractors find it more paying to sell their wood as charcoal than as firewood, because its transport is cheaper and wagons are readily available, whereas firewood transport is comparatively far more expensive. Even a casual observer can see that this lucrative export trade, apart from the fact that it has raised the price of firewood, is proving the bane of the forests. So long as forest contractors find it more profitable to sell wood after conversion into charcoal, so long will cowdung compete with firewood, and thus will continue to be used as fuel in preference. The export of charcoal must therefore be restricted. When this is done the prices for exported charcoal are likely to go up further. It will then be desirable that this export is so regulated that the bulk of the profits come to Government, which could utilise them to create village plantations. For the present these profits go merely to swell the coffers of the forest contractors.

Another important fact to remember when considering the utility of cowdung as a fertiliser *vis-à-vis* fuel is that from the manurial point of view excretions of concentrate-fed animals are far richer in nitrogen and phos-

* "It is often urged that what (cowdung) is used as fuel should be utilised for manurial purposes and the fuel requirements met in other ways. . . . The practical difficulty, however, is to find another equally satisfactory fuel. The alternatives are coal, wood and oil. Under existing conditions all three are expensive in most places owing to heavy costs of transport. . . . Steps have . . . to be taken to make wood available at a cheap rate. . . . For this purpose fuel plantations should be established as soon as practicable."

—Memorandum on the **Development of Agriculture and Animal Husbandry in India**, of the Advisory Board of the Imperial Council of Agricultural Research.

phorus contents than of animals subsisting mostly on roughage picked up on poor grazing grounds, as the following figures* of analysis show:

	Bullocks.		Dairy cows.
	Cake-fed.	No cake	
Ammoniacal Nitrogen ..	0.181	0.040	0.091
Total Nitrogen ..	0.773	0.540	0.427
Dry matter ..	27.40	27.20	19.44
Ash ..	5.72	9.47	4.17
P_2O_5 ..	0.389	0.235	0.193
K_2O ..	0.601	0.670	0.436

Nearly 90 per cent. of the stock of the province subsists on grazing. Thus practically all the urine, which is richer in nitrogen contents than dung, is lost. The utilisation of oilseeds is also closely connected with cow-dung economy. At present vast quantities of oilseeds produced in the province are exported. The telescopic rates to ports give an impetus to this efflux. This will need to be stopped by encouraging oil-pressing and placing a ban on export of cake. Similarly, grass will have to be made available in larger quantities and at cheaper rates to popularise stall-feeding to be able to utilise cattle urine.

NURSERY BED SHELTERING AND SHADING

By The Central Silviculturist, F.R.I., Dehra Dun

The following is an account of an experiment done in the demonstration area of the Forest Research Institute, Dehra Dun, to test the suitability of a technique for determining the effectiveness or otherwise of different methods of sheltering and shading a sensitive species in a nursery.

The nursery is situated at an elevation of 2,200 feet on alluvial soil varying from a hard gravel loam to a deep rich loam sometimes rather clayey. The characteristic property of the area is that it is an exhausted wheat soil. The rainfall averages 84 inches per year and most of this falls in the south-west monsoon from mid-June to the end of August. The hottest month is May with a maximum temperature which occasionally reaches 110°F. and the coldest month is January with a minimum of 28°F. to 30°F.

The species used was *Adina cordifolia* and the experiment was started in 1940 but early and heavy monsoon rains flooded the area, disturbed the seeds and vitiated the experiment. The experiment was repeated in 1941, 1942 and 1943.

The shades and shelters were of three kinds: (1) thatch 100 per cent. (2) batten 66 per cent and (3) unshaded controls. The shades were fixed slanting towards the south-east sloping from 5-foot height to 4-foot height above the bed. The times at which the shades and shelters were used were: (1) sheltering from rain during the monsoon, (2) shading from the sun before and after the monsoon and (3) shading from the sun before and after the monsoon combined with sheltering from the monsoon rain. Each type of shade and shelter was used with each time of shading and sheltering.

Stock used and method of sowing.—Local seed was collected in May. In early June the nursery beds were dug to 18 inches depth and the soil thoroughly powdered. The top 6 inches of soil was again worked and 2½ feet of pine needles compressed on each bed and

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*Vide *Encyclopaedia Brittanica*. 14th Edition.

burned, leaving an ash layer of about $\frac{1}{2}$-inch thickness. The ash was worked into the soil. The seed of *Adina* without being husked was mixed with twice its volume of sand and sown without presowing treatment. Seed was sown at the rate of $\frac{1}{2}$ oz. of seed to 4 bed sections each 8 feet by 4 feet (*i.e.*, per 128 sq. feet of bed). The sowing was done in the first week of June each year.

Layout.—The experiment consisted of 12 nursery beds each of which was divided into four bed sections each 8 feet by 4 feet.

Treatments were applied at random in the following arrangement:

Block									Block
1	C	F	A	G	C	G	G	D	4
	D	E	G	B	A	F	E	B	
2	G	G	E	A	G	D	B	C	5
	D	F	B	C	A	F	G	E	
3	F	G	B	A	A	E	G	D	6
	G	E	D	C	C	B	F	G	

Round each section of every bed a surround of one-foot width was left in order to avoid marginal effects. The shades were fixed directly after sowing and normal nursery procedure was followed. Drains were made all round and in between the beds to avoid flooding and the beds themselves were raised about 6 inches above ground level.

At the end of every growing season in December the seedlings in each sub-plot were counted.

Results.—The average number of seedlings per treatment and per season were:

Treatment	SEASON			Average per treatment
	1941	1942	1943	
A.—100 per cent. monsoon sheltering ..	775	82	470	442
B.—66 per cent. monsoon sheltering ..	1,538	407	432	792
C.—100 per cent. non-monsoon shading	7,151	1,653	1,680	3,595
D.—66 per cent. non-monsoon shading.	7,688	1,364	1,256	3,425
E.—100 per cent. A+C ..	4,320	1,504	1,078	2,300
F.—66 per cent. B+D ..	3,588	597	480	1,555
G.—Open control ..	236	478	400	371
Average per season ..	3,229	820	774	

The results were analysed statistically and differences between seasons and between treatments were generally significant. It is unnecessary to go into the analysis details in this summary.

The results show:

1. That with either shading or sheltering there was very little difference between the results provided by 100 per cent shades or shelters and those provided by 66 per cent.

2. That shading before and after the monsoon had a very great effect in increasing the numbers of survivals while sheltering during the monsoon had very little effect. Sheltering during the monsoon combined with shading before and after the monsoon had an effect intermediate between the separate effects.

3. The unshaded unsheltered controls gave far the poorest survivals.

4. The plant production per bed fell off very rapidly after the first year and the fertility was not maintained by burning and manuring each year with ash. [This is very striking confirmation of the results obtained with teak-stump production in Madras nurseries (vide *Indian For. Rec.* (n.s.) *Silviculture*, Vol. 4, No. 5.]

Discussion.—The technique used is suitable for the purpose but should be improved. There were 2 sets of control plots in each block (7 treatments in 8 bed sections). This is unnecessary and is an added complication. In a randomised block arrangement each treatment should occur only once in each block. The two sets of control plots differed only insignificantly each year and hence their average has been taken for purposes of comparison.

The same arrangement of the layout was used throughout. This should be avoided and the allocation of sub-plots to treatments should have been done at random each year.

It is also to be noted that the conclusions of the experiment only refer to one species (*Adina*) and one locality (Dehra Dun) and there is no possibility of general application.

The experiment does, however, demonstrate a technique suitable for the problem.

COPPICING OF SAL

BY RAI BAHADUR S. K. BASU,
(*Divisional Forest Officer, Kalimpong, Bengal*)

Our knowledge of the coppicing power of *sal* of different ages and in different localities is somewhat meagre. In view of this, the following account of an experimental coppicing of a *sal* plantation may be worth recording:

Locality.—Plains adjoining the foothills of the Darjeeling district east of the Tista river—Kalimpong Forest Division. Lethi block near Ghish forest bungalow. Elevation above sea level, approximately 700 feet. Rainfall 170 to 190 inches per year. Underlying rock—Sandstone.

The crop.—*Sal* plantation 1918 (age 25 years). Fully stocked. Average height 40 feet.

An area of 1.7 acres in the 1918 *sal* plantation was demarcated for the experiment the object of which was to see whether a good type of fuel could be inexpensively supplied on coppice rotation. There were 211 *sal* trees which formed the main crop. At the end of January, 1944, all the miscellaneous trees (in the lower storey of the crop), all undergrowth and the creepers as far as they could be reached were cut and burnt.

The *sal* trees were then felled. The stumps were clean cut at a height of not more than nine inches from the ground. Felling of *sal* was completed by 15th January, but no burning was done subsequent to *sal* felling.

Coppice shoots started sprouting (from the sides of the stumps) about the middle of April and continued to do so up to the end of July, 1944. Out of the 211 stumps, however, only 56 coppiced, as shown in the statement below. Unfortunately girths at breast height had not been recorded.

Girth at ground level in feet	1 to 2	Over 2 to 3	Over 3 to 4	Over 4 to 5	Over 5 to 6	Total.
Number of trees felled ..	13	63	83	45	7	211
Coppiced successfully ..	10	27	17	2	0	56

Remarks.—McIntire (quoted by Troup) said in 1909 that in the dampest parts of Bengal, *i.e.*, in the *Terai* and in the Tista valley, *sal* was a bad coppicer.

Young *sal* plantations of less than one foot girth accidentally burnt and allowed to coppice have been known to coppice very well in Tukriajhar in the Kurseong *Terai* and at Rajabhatkhawa in the Buxa Duars.

It is possible that had the plantation been of younger age and had a hot fire been allowed to run over the area after the *sal* had been felled, better results might have been obtained. Apparently, size has more to do with it than age.

Note on the above by the Central Silviculturist

The coppicing power of *sal* has usually been determined with regard to the size of the tree and not with its age. It has further been found that within the fairly wide limits of roughly one foot to four feet girth at breast height it is the vigour of the tree that makes for successful coppicing.

A correlation with age (except in the case of plantations) would be difficult as agreement has not yet been reached on how far the rings of *sal* are annual.

A comparison of U. P. data with that in the above article shows that this new data is not very abnormal and confirms the existing information on the subject that the coppicing power of *sal* falls off rapidly with increase in size and that this falling off is considerably more rapid in the wetter parts of Bengal than, for example, in the drier U. P.

U. P. Data		Kalimpong Data	
Girth at breast height	Percentage of successful coppicing	Girth at breast height	Percentage of successful coppicing
1′-6″ to 1′-11″ ..	84	0′-10″ to 1′-8″ ..	77
2′-0″ to 2′-11″ ..	66	1′-8″ to 2′-6″ ..	42
3′-0″ to 3′-11″ ..	42	2′-6″ to 3′-5″ ..	20
4′-0″ to 4′-11″ ..	21	3′-5″ to 4′-3″ ..	4

Several points of interest are noted in this Kalimpong data. The plantation crop at 25 years old had approximately 124 stems per acre and a mean breast-height diameter of about 11 inches with a wide distribution of diameter classes. It was thus apparently an understocked plantation in which the trees had grown up comparatively free and had attained a much bigger size for their age than would be expected. This may have affected their coppicing power.

A rough comparison is with Howard's coppice yield tables which show at 25 years crop diameters of 7 inches for Quality A and 5 inches for Quality B.

BELIEVE IT OR NOT!

(A True Bengal Tiger Story)

BY J. N. SEN GUPTA

(Divisional Forest Officer, Buxa Division, Bengal)

The Khuntimari forest village at Borobisha in the South Bholka Reserve, Buxa Division, recorded an unusual incident that might be of interest to many a sportsman. The place of occurrence was to the west of the Sankos river, which forms the provincial boundary between Bengal and Assam—locally known as the Eastern Duars; and the type of forest is between the wet-mixed and the savannah, with a sprinkling of *sal*, which has always been the favourite haunt of big game sauntering about between the territories of Assam, Bengal and the Cooch Behar State forests. These areas are ideal places for tiger-shooting.

It was about dusk on the 10th June, 1944, when one tiger quietly stole into a cattleshed of the forest village and attacked a cow therein. This caused some flutter, which drew the attention of the caretaker, who hurried to the spot. But no sooner did he appear on the scene of occurrence than the tiger, already annoyed with the struggling prey, left the cow, made for the man and chased him right up to the door of his dwelling hut, caught and mauled him badly; and, what was most striking, started sucking his blood. A bold neighbour went to his rescue with a large stick in his hand, which he brandished at first, and then hit the tiger hard with it. The instantaneous reaction was that the beast left the first man, turned towards the second and killed him on the spot. Fuming and raving menacingly, the furious beast then circled round the hut and the cattleshed till he entered the latter again, killed in quick succession five cows, one goat and a hen that was only hatching her eggs in one corner—all inside the shed. Apparently, having sucked their blood to his heart's content, he kept on roaring intermittently till about 3 o'clock in the morning when he fell asleep and lay down quietly inside the cattleshed.

The panic in the village was indescribable, and no one stirred from his hut during the night. At dawn, however, one took courage to quietly peep into the cattleshed through a hole in the wall, and was horrified at the ghastly sight of so many dead animals in between the living ones, while the proud killer—the hero of this tragedy—was sleeping comfortably after his hearty meal. The villager ran straight to the Beat Office (about two miles off) and broke this news to the Forest Guard, Chand Bahadur Gurung.

Chand Bahadur, the proud retainer of a (Government) .12-bore single-barrel shotgun and only four rounds of ammunition (two ball and two L.Gs.), marched off immediately to the place of occurrence, whence all human beings had long disappeared; and he found none ready to accompany, or stand by, him. Undaunted, the Forest Guard alone cautiously went and peeped into the shed and saw that the tiger was still asleep. He then climbed on the low and somewhat rickety thatch-roof of the cattleshed as noiselessly as he could, was plucky enough to make a hole in the roof with his fingers, and shot the tiger dead with a bullet hitting him right on the temple, from a range of about 9 feet only.

The tiger measured full nine feet. It was a tragic sight for the people in the neighbourhood to watch the funeral procession of a dead tiger and its first victim—a severely mauled villager groaning under multiple wounds and gasping for breath being carried to the range headquarters at Kumargramduar—at a distance of nine miles—which was the nearest place for rendering medical aid; but the poor man died on the way to the hospital. Thus ended the career of a Bengal tiger and his nine victims of two Nepali hill men, five head of cattle and one bird—all in one evening only—a unique record for all that we know!

We have managed to get Forest Guard Chand Bahadur Gurung a reward of Rs. 50 from the discretionary grant of the Divisional Commissioner—the highest permissible in such cases, and another of Rs. 20 from the Toorsa-Sankos Fishing and Shooting Association. The bravery and gallant action on the part of this Forest Guard should encourage others to emulate his example.

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TRANSPORT PRODUCER-GAS CHARCOAL MANUFACTURE AND CONTROL

By R. L. Derry, I.F.S.

The necessity of planning the manufacture, distribution and price-control of suitable charcoal for producer-gas purposes was raised by the Provincial Motor Transport Controller in respect of Bihar transport generally with the Conservator of Forests and the Forest Research and Working Plans Officer. After a preliminary discussion on the 20th July, 1944, it was agreed that a more comprehensive meeting would be necessary to consider the many difficulties involved, with selected forest officers, forest contractors and motor-transport dealers.

Two meetings were held on the 4th and 5th August, 1944. In the first instance with the forest officers and the Provincial Transport Controller to arrive at certain limits of Government control that were considered necessary to impose for a reasonable output of suitable charcoal; and in the second instance to work out details with the forest contractors and transport dealers for the satisfactory execution of these essential requirements. In conclusion, the following arrangements were arrived at:

(*A*) A planned scheme should be introduced for the Government-managed forests to coincide, if possible, with ensuing annual auctions in September, 1944, so that regular supplies would become available from November-December, 1944. It is anticipated, with price and transport control for the selected grade of charcoal, many *zamindari* forest owners will be induced to fall in line with the Forest Department as provided for in (*G*) below. In these auction sales provisions are to be made for extending the time allowed for exploiting timber and poles in the coupes/lots so that all residue can be converted into charcoal.

(*B*) For producer-gas purposes in motor propulsion the grading standards laid down in Forest Research Institute Leaflet No. 18 (Chemistry) of 1942 will be the guiding objectives. But allowances have to be made in respect of those standards based on laboratory tests that it would be impracticable to apply in the conditions now prevailing in forest areas. Primarily, therefore, the standards for a suitable charcoal will be:

(1) Any local forest species other than *Tamarix* and *Ficus* Spp. and till they have been successfully tested, any species, such as *semal* and *chatni*, having a green weight of less than 50 lbs. per c. ft.

(2) Adequate carbonisation that would yield a clean burnt piece of blackish colour throughout of obvious metallic lustre on fracture, and of firm consistency to normal hand pressure.

(3) Of a size that will be retained on a wire sieve of $\frac{3}{8}$-inch mesh.

(4) Air-dried and maintained as such under shelter till its utilisation as producer-gas.

(*C*) The price of charcoal of the graded standard laid down in (*B*) above shall be Rs. 3 per maund packed and sewn in gunny bags at (*i*) the nearest selected all-weather roadside dépôt or railway station; (*ii*) selected Forest Department fair-weather roadside dépôt that can be conveniently reached by a motor-truck propelled by producer-gas. In the interests of manufacturing contractors and to provide for a supply of charcoal for ordinary domestic use, the residue charcoal not fulfilling the standards specified may be sold by private arrangement at a price not exceeding 12 annas per maund at any recognised hut or forest

* Compiled under the supervision of the Conservator of Forests, Bihar.

dépôt, and at a price not exceeding rupees two per maund for charcoal manufactured outside the limits of the Government-managed forests not coming within the scope of this scheme as given in (*G*) below. These rates are subject to revision every six months in relation to the labour and market rates then prevailing.

(*D*) For the year ending 31st March, 1946, there will be a minimum supply of 6,000 tons of graded charcoal from the Government-managed and other forests. It is recognised that the manufacture of charcoal has only been a sporadic and subsidiary local forest industry in the past and no attempt has been made to base this on any graded standard: (*ii*) skilled operatives are limited and will have to be trained up; (*iii*) the Forest Department is already heavily committed in the supply of numerous forest products for war purposes; and (*iv*) there is an acute shortage of local labour and transport facilities. But all graded charcoal will be purchased at the stipulated price through the Provincial Motor Transport Controller. In the light of this assured market and as the general process and organisation of manufacture is developed and improved, it is anticipated that an appreciably larger yield of graded charcoal will become available for motor propulsion.

(*E*) In order to assure that this new industry is provided a reasonably good start and adequately developed and that the interests of Government are maintained in the light of the provisions given in (*A*) to (*D*) above, it is considered necessary for Forest Department on their part to make or to have provided the following:

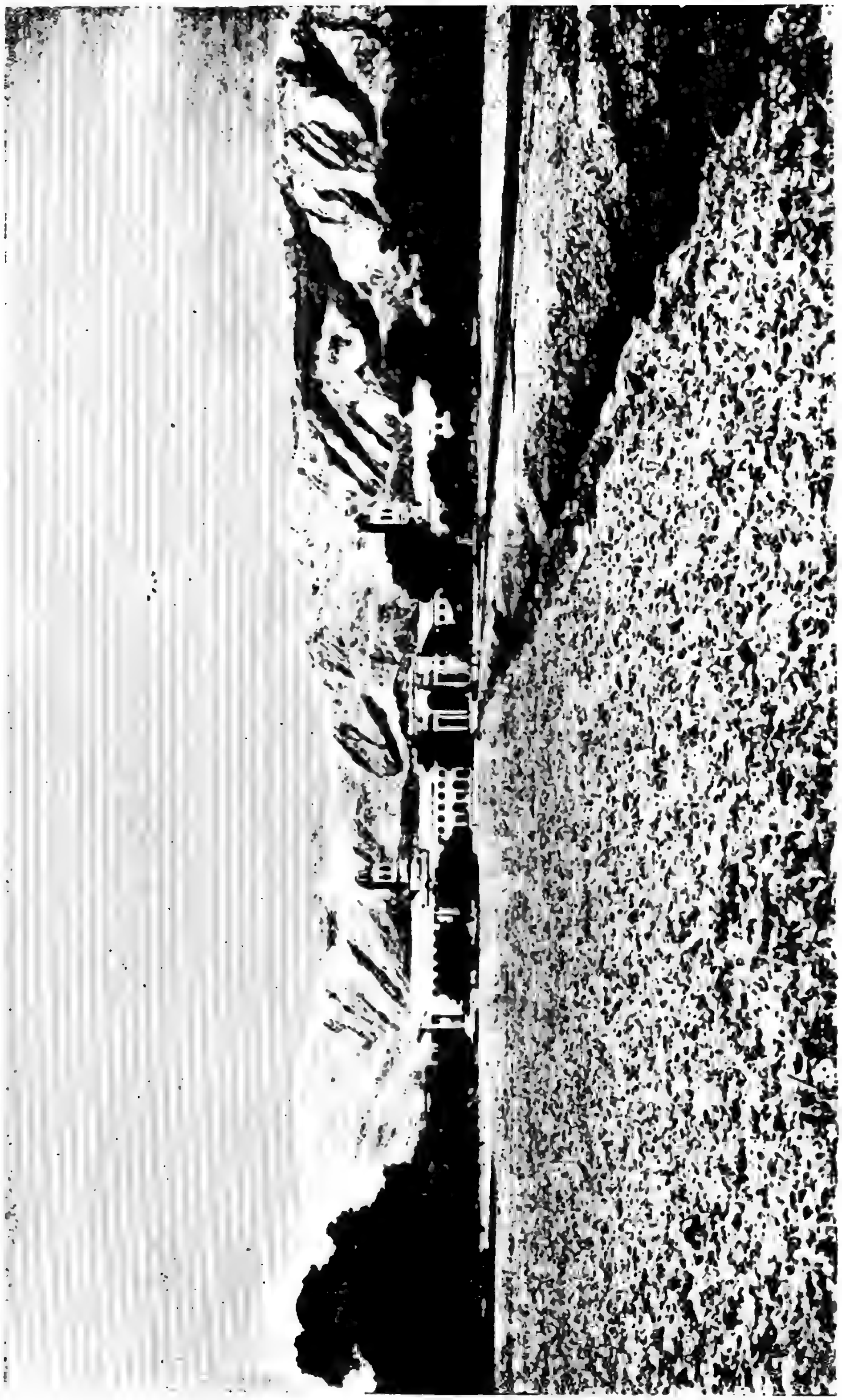
(*i*) In all forest coupes under exploitation the residue crops that cannot be utilised as timber, logs or *ballies* (poles), etc., for Defence supplies, shall be available for conversion into charcoal. It is recognised here that allowance must be made for the large local and military demands for firewood and for reasons cited in (*D*) above, the full residue could not now be converted into charcoal. But to ensure an obligation to manufacture charcoal, the Divisional Forest Officer shall have powers to insist that 50 per cent. of the residue available shall be converted thus into charcoal.

(*ii*) All charcoal production in respect of its manufacture shall be suitable for yielding primarily material of the graded standard defined in (*B*) above. For the present this will have to be in kilns of the earth-dome design which shall be maintained to give adequate carbonisation. In view of the lack of experience to date in the technique of operating such kilns, six inspectors of suitable qualifications shall be appointed and sent to the Forest Research Institute for special instruction. Their main functions will be: (*a*) to advise on local improvements in the manufacture of charcoal; (*b*) to keep the Divisional Forest Officer informed on the progress and standards being maintained; and (*c*) to supervise generally the grading work and other matters relating to operations as a whole.

(*iii*) Endeavour will be made under special priority to get four metal "Frikilns" prepared which the Forest Department will give on hire to contractors as these not only yield a larger and better quality output of charcoal but can be transported and used on sites where a regular water supply is not available as is necessary with the common earth dome kiln. The erection of permanent brick-kilns will be considered also on the progress of development.

(*iv*) For each divisional unit a number of dépôts will be constructed through the Forest Department and maintained in the light of (*C*) above. These will include suitable shelters for storing the bagged charcoal prior to delivery to the transport dealers. A list of such dépôts, as provisionally selected, is provided in the tabular statement appended,* it being realised that working experience may necessitate changes or additions. Here the forest contractors will deposit their prepared charcoal which will then be screened for size, graded and bagged. The filled bags will then be sewn up with an attached metal seal press-

* Omitted.—*Ed.*



Forest Research Institute, Dehra Dun, under snow for the first time for forty years.

January 11, 1945.

Photo: V. K. Sharma.
Silviculture Branch, F.R.I.

ed with the Forest Department facsimile. The *muharrirs* (clerks) will maintain an account of deliveries, stocks and collections, etc., which will be furnished to the Divisional Forest Officer and the Provincial Motor Transport Controller monthly. By special arrangement the screening, grading and bagging may be carried out in the forest near the manufacturing sites provided the forest contractor meets the costs of additional *muharrirs* for the purpose, after which it will be moved to the collecting dépôt.

(*F*) In co-operating with the operation of the above scheme the Provincial Motor Transport Controller on his part will arrange for the following:

(*i*) Provide the Forest Department with a list of dealers registered to purchase the bagged and sealed charcoal from dépôts.

(*ii*) In order to start operations he will provide the Forest Department with 30,000 gunny-bags and thereafter will see that these dealers make over empty bags for the filled ones collected at any dépôt together with their pressed seals. It is implied that dealers will only accept filled bags with such pressed seals thereon.

(*iii*) All graded charcoal shall be purchased at the prices stipulated in (*C*) above and payments will be made on a cash basis at the time of collection to the forest contractor or his agent, even where this exceeds the proposed minimum supply in (*D*) above. Furthermore, he will arrange that it is conditional on the appointed dealer to make advance deposits with the forest contractor up to 75 per cent. of the value of bagged charcoal that has been lying at a dépôt uncollected for more than two months and a half.

(*iv*) He will arrange for safeguarding the interests of the Forest Department in respect of these graded supplies wherever these may be stored prior to sale to public.

(*v*) He will arrange for the supply of petrol-driven trucks to forest contractors to transport charcoal from the manufacturing sites to the collecting dépôts as may be deemed necessary by the Conservator of Forests to meet the already overburdened demands on carting, etc., in the forest areas.

(*G*) Any forest owner or contractor operating in a privately-owned forest of Bihar shall be allowed to come into the scope of this scheme provided:

(*i*) Government is satisfied with the *bona fides* of the applicant and there will be a regular and satisfactory yield.

(*ii*) He will conform to the provisions of (*E*) above under Forest Department supervision and for which he will have to include the cost involved except the charge on account of special "Inspectors."

(*H*) It will be necessary for Government to issue notifications in respect of (*B*), (*C*) and (*F*) (*ii*) and to withhold the transport and sale of any such charcoal except to registered dealers within the province limits, and the export of any charcoal, graded or otherwise, outside provincial limits except under licence.

SNOWFALL IN DEHRA DUN

By A. L. Griffith

(Central Silviculturist, F.R.I., Dehra Dun)

On the night of January 10th approximately three inches of snow fell in Dehra Dun. As far as can be ascertained this is the first authentic snowfall in Dehra. There was an alleged light fall in 1904 or 1905 but there is no record of this; about 1885 or 1886 snow came down as far as Rajpur, and there is a legend of snowfall somewhere in the 1820s. There is, however, no doubt of the fall this year as the photographs in *Plates 6, 7 and 8* show.

After slight rain during the day, fairly heavy rain fell from 6 p.m. At about 9 p.m. this turned to snow and it continued to fall for about four hours up to midnight. After this, further rain fell and the whole lot, snow and rain, froze up solid. Altogether 0.98 inches of rain fell in the 24 hours and this

includes the water from the melted snow.

The minimum temperature at the New Forest standard meteorological station at four feet six inches registered 29 F. and this means that the grass temperature was about 21° to 23 F.

The vegetation of the New Forest estate is most of it about 15 to 20 years old and largely consists of exotics. For many of these it was probably the first time in history that any of them had suffered snow—and some of the results were disastrous.

Many species suffered severely from breakage. Main stems were broken in a very large percentage of the teak (*Tectona grandis*), *Casuarina equisetifolia*, *Albizzia procera*, *Dalbergia latifolia*, *Acacia catechu* and *Cassia* spp. Severe damage by breaking of branches was suffered by *Cassia fistula*, *Anthocephalus cadamba*, *Terminalia myriocarpa*. Other species survived the snow but suffered after-effects from the cold as they thawed out again. Notable among these were *Chikrassia tabularis*, *Acrocarpus fraxinifolius*, *Markhamia platycalyx*, *Schleichera trijuga*, *Eugenia jambolana* and young coppice of *sal* (*Shorea robusta*).

One of our most serious losses is in the long-term experiment on the heredity of figure of *Terminalia tomentosa* (*Fig. II, Plate 8*). Here the trees had reached a height of about 30 to 35 feet and a diameter of eight to 10 inches. Every stem has been permanently bent right down to the ground and all will have to be coppiced.

The bamboos generally lay flat on the ground and, as they thawed out, exploded with a noise like a shot-gun and sprang fairly upright again. Some internodes were completely burst by the thaw.

The grass (*Melinis minutiflora*) which is alleged to keep off snakes and mosquitoes was in full seed at the time and held its covering of snow (*Fig. II, Plate 7*) long after it had melted elsewhere. We have yet to find out whether the viability of seed has been affected.

The most unexpected escape from any damage was that of *Sterculia alata*. In normal years its branches frequently break due to the weight of its foliage. It was in full leaf at the time of the snowfall and yet breakage of branches was very rare.

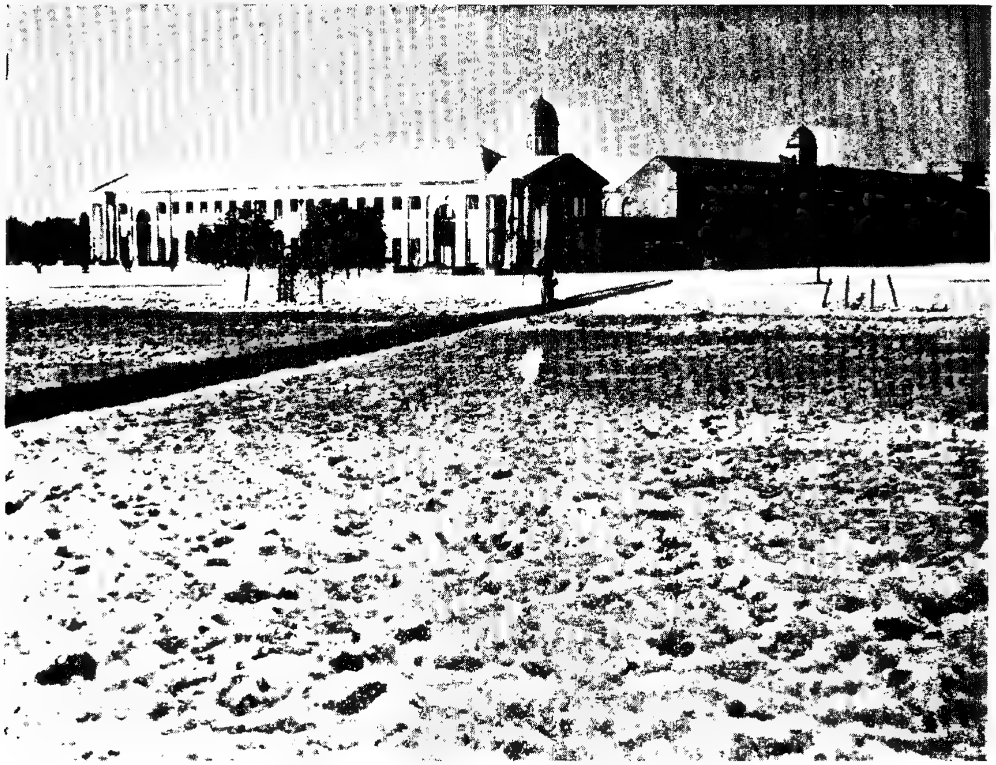
It was particularly noticeable that local species such as *chir* (*Pinus longifolia*), *sal* (*Shorea robusta*) and *shisham* (*Dalbergia sissoo*) were hardly affected at all.

A tabular classification of the damage is as follows:

Very heavily damaged.	Heavily damaged.	Mildly damaged.	Undamaged.
Acacia auriculiformis.	*Acacia catechu.*	*Adina cordifolia.*	*Agathis palmerstonii.*
Albizzia procera.	*Anogeissus pendula.*	*Bauhinia purpurea.*	
Anthocephalus cadamba.	*Bambusa polymorpha.*	*Cedrela toona.*	*Alnus nepalensis.*
Bischofia javanica.	*Boehmeria regulosa.*	*Celtis australia.*	*Araucaria bidillii.*
Cassia fistula.	*Dendrocalamus longispathus.*	*Celtis tetrandra.*	*A. cookii.*
Cassia siamea.		*Dendrocalamus strictus.*	*A. cunningg hamii.*
Casuarina equisetifolia.	*Dodonea viscosa.*		
Dalbergia latifolia.	*Horenia dulcis.*	*Jacaranda ovalifolia.*	*Carallia integerima.*
Ficus benjamina and other	*Markhamia platycalyx.*		*Chickrassia tabularis.*
Ficus, spp.		*Mangifera indica,*	
Macaranga denticulata.	*Melinis minutiflora.*	*Michelia champaca.*	*Cinnamomum camphora.*
Tectona grandis.		*Psidium guava.*	*Cornus florida.*
Terminalia arjuna.	*Pterospermum marsupium.*	*Shorea robusta.*	*Cryptomeria japonica.*
Terminalia myriocarpa.			
Terminalia tomentosa.	*Trewia nudiflora.*		*Cupressus sempervirens.*
			Cupressus torulosa.
			Dalbergia sissoo.
			Eucalyptus spp.
			Grevillea robusta.
			Litchi.
			Mallotus phillipinensis.
			Pinus caribaea.
			Pinus longifolia.
			Sterculia alata.
			Taxodium mucronatum.

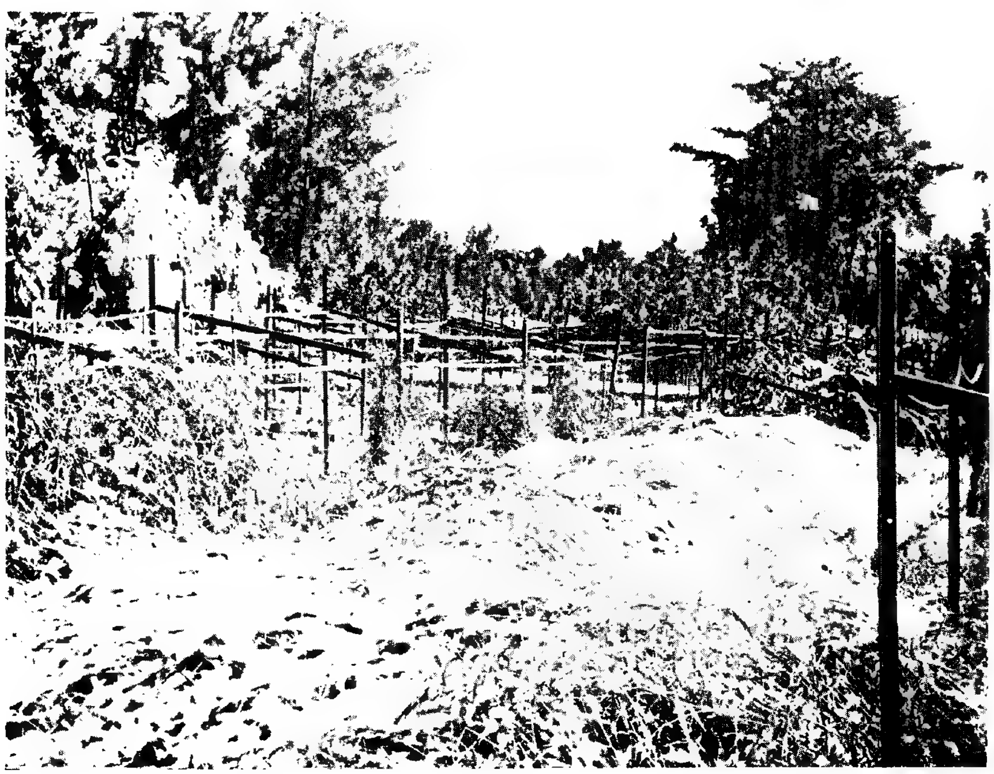
The illustrations were taken by the silvicul-turist and the photographer of the Silviculture Branch of the F.R.I.

Fig. I



A crop of ground nuts (**Arachis hypogaea**) on the terraces of the F.R.I.
January 11, 1945.

Fig. II



The grass that "keeps away snakes and mosquitoes" (**Melinis minutiflora**) seeding under snow.
January 11, 1945

Fig. I

Snow breakage in 16-year old teak (**Tectona grandis**).

Fig. II

Snow bend in **Terminalia tomentosa.**

PROSOPIS JULIFLORA IN JALGAON RANGE, WEST BERAR DIVISION, CENTRAL PROVINCES AND BERAR

BY KHAN BAHADUR S. R. DAVER

(E. A. C., Forests.)

The following observations, which I have recorded after a visit to the Bhongaon forests of Jalgaon range in February, 1943, may be of interest to other officers who are concerned with this species, and will, I hope, lead to exchange of experience.

CONFUSION ABOUT THE VARIETY OF *P. JULIFLORA*

Troup writes that this species is very variable and mentions the following varieties:

(*i*) *P. juliflora*, variety *velutina*, is said to be the more useful timber variety, the tree reaching a height of 50 feet and a diameter of two feet.

(*ii*) *P. juliflora*, D.C., a typical variety (or species) is a small evergreen tree usually unarmed.

(*iii*) *P. pallida, H.B. and K.*—Successfully introduced into Ceylon. Its pods contain as much as 90 per cent. of tannic acid and are highly valued in tanning. They are imported into Europe under the name of "Algarobilla" or "Balsamocarpon" (Gamble).

(*iv*) *Prosopis juliflora*, variety *glandulosa*, Sarg. Syn. (*Prosopis glandulosa*, Torr.) is a small or moderate-sized deciduous tree, armed with stout, scattered axillary thorns: it appears to have been first introduced into India in 1877 from seed obtained through Kew and, in some of the drier parts of India, has proved of great importance for afforestation work, for which purpose it deserves further attention. It is recommended for planting up shifting sands in dry localities. It is also a useful source of supply of fuel, of famine fodder and of food for man in times of scarcity, the pod being sweet and edible.

P. juliflora yields a large quantity of gum; this fact is not mentioned by Troup, but the plants introduced in 1934-35 as Mexican variety in the Jalgaon range are exuding gum, which suggests that it is none other than *P. juliflora*.

In the last para. (Troup's Vol. II, page 402) Troup makes it clear that the variety he imported from Mexico was *P. juliflora*, variety *glandulosa*. I give two extracts from this para.: . . . "During the last 18 months I have received several consignments of *P. juliflora* seed from Mexico and in each case found a very large proportion of the seed destroyed by weevils. . . "As seed is produced in abundance in India, there is no need to import it from America, unless the object be to obtain other than variety *glandulosa*."

Mr. C. F. Bell, I.F.S., when he introduced *P. juliflora* in 1934-35 described it as Mexican variety. As all the varieties of this plant are indigenous to north and south America, including Mexico, the term "Mexican variety" does not convey a correct description.

In the working plan for the plain forests of Amraoti division in para. 61, Mr. W. N. Sharma writes that in *chunkheri* (calcareous) soils, the Australian variety of *Prosopis juliflora* has given indication of success in the Akola division and he prescribes that it should be tried in poorer soil where *babul* has failed.

In para. 39 of the new working plan for the Buldana forest sub-division, Mr. S. A. Cornelius describes the old stemless variety as Brazilian variety and the Mexican variety of Mr. C. F. Bell's description is changed into Australian variety in this plan. At any rate, the plant introduced recently by Mr. W. N. Sharma in the Amraoti division from Akola is identical with the so-called Mexican variety which I prefer to call *P. juliflora*.

We have bitter experience in Jalgaon range where we have now two varieties of *P. juliflora* as suspected by Rai Bahadur D. R. Datt. The old one is stemless and useless over which money and energy was spent in

vain for 15 years Since the writing of this note, the Divisional Forest Officer, West Berar division, collected specimens of two varieties of *P. juliflora* from the Bhongaon Reserve and despatched them to the Forest Research Institute, Dehra Dun, for identification. The two species have been now identified as:

(1) *Prosopis glandulosa, Torr.*
(2) *Prosopis juliflora, D. C.*

The Divisional Forest Officer, West Berar, reports that *Prosopis glandulosa* is now considered to be unsuitable and the sowing of which has been abandoned and *Prosopis juliflora*, which is the favourite and is now sown exclusively in the Bhongaon Reserve. I am grateful to the Forest Botanist, Forest Research Institute, Dehra Dun, for the correct identification of two species and in the light of this information I have modified my original note.

Forest officers who have had to deal with the *P. juliflora* plantations in the West Berar division have expressed the following opinions:

(*i*) Mr. C. F. Bell, I.F.S., declared that this was a quite unsuitable species for plantations and he had good reason for being dissatisfied with the old variety which is a stemless bushy form. After his visit to the Punjab, he not only changed his opinion, but imported seed from the Punjab under the name of Mexican variety which is the erect form.

(*ii*) Mr. C. M. Harlow, I.F.S., writes that he met Mr. Mohan, I.F.S., of the Punjab plantations who informed him that their seed had been badly mixed and it was thought that we had got a wrong variety. Under these circumstances he suggested that further trials be given to this species.

(*iii*) Mr. K. C. Ray, I.F.S., summarises his opinion as noted below:

(1) Percentage of germination of seedlings is high and sowing and transplantation operations are easy.

(2) It grows well in good black cotton soil but he thought it would not do well in poor soil or soils containing lime or other salts.

(3) It has a peculiar habit of throwing strong lateral branches at the base. This creeping behaviour he notes in all his reports.

(4) He has suggested that these lateral branches should be pruned to encourage the plant to become an erect form.

(*iv*) Rai Bahadur D. R. Datt holds a very high opinion about this species. I sum up his views as noted below:

(1) It has done well and even better than *babul*.

(2) Its growth is very rapid, plants four years old are 12 to 15 feet high.

(3) It has seeded in the third and fourth year of its growth.

(4) It grows on good and bad soil equally well.

(5) He found one *P. juliflora* tree in coupe No. 14 in a crop 12 years old: it has six stems from 12 inches to 26 inches in girth and the tree is 30 feet high. The two larger stems measured 22 inches and 26 inches in girth. (By a strange coincidence, I happened to see this tree during my visit. Rai Bahadur D. R. Datt will be interested to know that the largest stem which he measured in March, 1939, to be 26 inches is now $33\frac{1}{2}$ inches in girth on 26-2-1943.)

(6) The volume of outturn will be more than that of *babul*.

(7) No doubt, he writes, it has got a bushy habit which may partly be due to our sowing two or three seeds together.

(8) Wood is very hard and heavy and it will make good fuel and will be useful timber and can compete with *babul* on equal terms.

(9) It is immune from insect attack.

I agree with Rai Bahadur D. R. Datt's views on most of his points; in fact the large successful areas of *P. juliflora* are a monument of his personal zeal and direct proof of his opinion. However, on certain points I do not agree with him.

(*a*) The pods of *P. juliflora*, variety—Mexican, are indehiscent. Consequently pods are broken into bits and each

bit, holding two or three seeds, is sown by hand in the plantation. This fact led many officers into the belief that the branching of the stem at ground level (bushy nature) is due to our sowing two or three seeds together. "If this is so"—argued R. O. Jalgaon, "why are seedlings of one and two years age in the plantation single stems in almost all cases?" It is not likely that one or two seeds remain dormant for two years and one seed germinates as seedling. The fact is, this branching of several stems at ground-level is the peculiar habit of *P. juliflora*. Troup observes: "The habit of *P. juliflora* is peculiar: most of the trees and all the natural seedlings I have seen branching at ground-level, giving several crooked branches. There is, however, an erect form, and the two big specimens in Khushalgarh had an upright habit not unlike that of *Acacia arabica*. This form, however, is not constant, as the seedlings from the Khushalgarh trees all showed the usual crooked habit." Therefore, the theory that sowing of two to three seeds together leads to branching of stem at ground level, is an exploded one.

(*b*) As regards Rai Bahadur D. R. Datt's opinion that the volume of outturn of *P. juliflora* will be more than that of *babul*, I would point out that the most valuable part of the tree is its bole, whether it is *juliflora* or *babul*. Even in the erect form of *P. juliflora* the bole is very short. The solitary big tree of *juliflora* in coupe No. 14, having six stems, has been frequently mentioned by Rai Bahadur D. R. Datt and by Mr. S. A. Cornelius in para. 39 of his plan, as an example of rapid growth and volume. The biggest stem of this tree had a bole only five feet 10 inches long to the first branching, when I measured it on 26-2-1943. On the other hand, both varieties of *babul* have boles 5, 10, 15 and even 20 feet long. For this reason alone *babul* is superior to *P. juliflora*. As regards the quality of wood, *babul* holds the highest place among the Beraris—both as timber and fuel, and owing to their extreme conservatism all other wood will hold a secondary place as long as *babul* is available from Government forests and private land.

In a certain lease in Bhongaon forest a contractor had about one ton of *P. juliflora*. He left this quantity in the forest and removed all *babul* to the market for sale, using *juliflora* as fencing posts or as firewood for his personal use. I asked the R.A. why the contractor did not remove *juliflora*. His reply was that the billets of *juliflora* were of small size. I have seen some of these billets; they were 1½ inches to two inches in diameter. This fact shows which way the wind blows. Thus even if we take for granted Rai Bahadur D. R. Datt's contention that the volume of outturn will be more than that of *babul*, still the price will be less per unit.

(*c*) As regards *P. juliflora* growing on poor soil, no doubt it grows in *chunkheri* (calcareous) soil where *babul* fails or remains stunted, but from this it does not follow that it can thrive on all kinds of poor soils, *e.g.*, in shallow soil *P. juliflora* survives only for one or two years and then dies.

I summarise my own observations regarding *P. juliflora* as under:

Economic Uses

Gum.—*P. juliflora* is a heavy gum-yielder. Contractors of Sagoda informed me that each tree exudes about one-quarter seer of gum during March, April and May. I have myself collected a few gum-tears during my visit. The size of each gum-tear is about one inch long and half an inch thick. I have particularly noticed that from the pair of thorns, one is dropped or shed, and from this point a gum-tear exudes. If this peculiar habit is studied and found to be constant, one has only to break off one thorn to induce the exudation of gum artificially, just at the commencement of the hot weather.

In this case there will be no ugly blaze or wound as inflicted on *kulu* (*Sterculia urens*) trees. It is very interesting to note that, of the pairs of thorns, one is dropped and its place is taken by a tear of gum while the other thorn guards the treasure. Monkeys do heavy damage to *babul* gum but they will

think twice before they touch gum on *P. juliflora* trees.

Gum is frosted outside and of yellow or straw colour inside. It is edible and pleasant to taste; villagers pick up gum for this purpose. It is also adhesive and its quality may be as good as gum arabic. It can safely be used for the manufacture of confectionery and jujubes. I think the Divisional Forest Officer, West Berar, would like to collect gum during the hot weather for sale as well as for investigation at the Forest Research Institute, Dehra Dun.

Branches.—Contractors informed me that unlike *babul* the branches of *P. juliflora* are long and straight and they can be put to the same use as bamboos, provided the formidable thorns are removed. These branches can also be used as fencing posts or fencing material owing to its hard, durable wood and presence of stout thorns.

Pods.—Owing to its sweet pulp, pods are readily sought for by wild and domestic animals.

Pods of *Prosopis pallida* (Kunth.) contain as much as 90 per cent. of tannic acid and are highly valued in tanning (Gamble). Pods of *P. juliflora,* I suggest, may be sent to the F.R.I., Dehra Dun, to ascertain their property in this respect.

Wood for Timber and Fuel.—The heartwood is of dark-purple colour not unlike *shisham* and the outer ring of sapwood is very thin, occupying a very small proportion of the wood. Heartwood is very heavy and durable. With all these points in favour of this plant we have no data to speak with authority that it can oust *babul* or that it can compete with *babul* on equal terms. The bole even of an upright form of *P. juliflora* is short—very short. We have no experience of this wood as fuel in Berar. All that we can say is that it will make good fuel or charcoal.

Thorns.—The thorns of *P. juliflora* are not only sharp and stout but I think they contain some toxin poison. Mr. Verma, E.A.C.F., from his own personal and bitter experience, informs me that the pain lasts for two days. People in Amraoti say that thorn wounds fester for many weeks. Villagers of Sagoda say that the victim of this thorn-prick feels a severe burning pain as if the person is stung by a scorpion. Animals, both wild and domestic, have a wholesome respect for this thorn and give a wide berth to the plant. But out of evil comes good, *i.e.*—(*a*) when one thorn drops off, we get a large bead of valuable gum, (*b*) as thorns for fencing, they are far superior to *babul* thorns, (*c*) these thorns protect the tree in an area subject to excessive browsing.

SILVICULTURAL CHARACTERISTICS

(1) The genus *Prosopis* is well known for developing a long tap-root system. A specimen of *Prosopis spicigera,* of which pieces were sent to the Paris exhibition in 1878, had a tap-root 86 feet long, penetrating vertically to a depth of 64 feet (Gamble). Mr. K. C. Ray, I.F.S., experimented in the West Berar division with *Prosopis juliflora* and found the tap-root of seedlings three times as long as the stem.

Successful plantations of *P. juliflora* on a large scale are found in Sind and the Punjab, and Troup remarks that *P. juliflora* has come to stay in the Punjab. In my opinion the successful expansion of *juliflora* plantations in both these provinces is mostly due to the deep deposits of sandy soil, where the tap-root has full scope for perfect development. Unfortunately in Berar the plantations are confined to areas where the soil is not very deep and it is of a clayey type. It is worthwhile trying *juliflora* on the loose sandy banks and islands in the Narbada, Tawa, Denwa and the Mahanadi rivers in C.P. and on the muddy banks of the Purna river in Berar where the mud-deposit is very deep.

(2) One peculiarity of *P. juliflora* is to throw out strong lateral branches almost at the base when plants are in the seedling stage. It performs some vital function in its native land of which we are not aware. One thing that I observe under the cover of every creeping

plant is a heap of leaf and straw litter. All these lateral branches, armed with thorns, act as collecting fingers. Does this litter act as vegetable mould or humus for the plant growing in sandy desert soil? It must be borne in mind that this plant grows in regions where rainfall varies between 10 to 20 inches, a semi-desert condition.

Another peculiarity of this plant already mentioned is its branching at ground-level even in the erect form of the tree. Thus we see lateral branches creeping on the ground when the plant is in a young stage. We also see branching of stems at ground-level when the plant is fairly old. Is it possible that the same creeping lateral branches of the seedling stage finally develop into stems at ground level when the plant gows old? This requires further observation by silviculturists. If this theory proves correct, then this is a plant which stoops to rise; another instance of its adaptability according to environments.

Subsequent observations elsewhere, at Chirodi in Amraoti division, have suggested to me that possibly rats are also a cause of lateral branching.

At the foot of a hill, in coupe No. I, Chirodi F.S., there were 1,032 *juliflora* two to four feet high when I first visited the plantation in November, 1941. To-day all have disappeared: at first, I thought all had dried up and perished, but, on close examination, I found that small coppice shoots, three inches to six inches high, were coming up from seedlings which had been destroyed by rats. Even these small coppice shoots are not spared—the terminal portions of shoots are gnawed in most cases. In some cases, when the rat could not get at the terminal shoot easily, it has cut off the branches or shoots at the base (where there are no thorns) and then started feeding on the tender parts of the terminal tips. I collected several dried-up branches near the stems—cut and damaged at both ends. If we look round, we find the ground riddled with rat-holes; in many cases, just at the base of the *juliflora* plant.

The damage to the small seedlings is so imperceptible that it may pass unnoticed if careful examination is not made. Shoots and tips, as slender as a needle, are gnawed and cut by rats.

It appears to me that when the terminal tip of the seedling is destroyed by rats, the plant's energy is concentrated on developing strong lateral branches. It is, therefore, necessary to find out whether this phenomenon of lateral branches in early stages is due to:

(*i*) The injury to the plant by rats; or,

(*ii*) Natural habit of the plant to collect litter as vegetable-mould round the stem: or,

(*iii*) Natural habit of the plant to retain moisture: or, possibly, all three.

In the previous paragraph, I have reported the damage inflicted by rats to the portion of the plant above ground when the plant is very young, but in older plants it is the root system which is attacked and the plant is completely destroyed. In the experimental plot of 1940 at Pohra, five trees of *juliflora* eight to 12 feet high, were killed in this way in 1942 in one row. This year one plant has been killed by rats since C.F.'s inspection in January, 1943.

We see rat-burrows under many stems of *juliflora*. In Wadhona experimental plot of 1940, there are over 300 *juliflora* plants seven to 10 feet high, but there is hardly a single *juliflora* plant which does not harbour one or two rat-burrows. I have not yet seen any tree being killed, but many have been destroyed unnoticed.

It seems that, in the young stage, the upper portion of the plant is more palatable to the rat and, as the plant grows old, the rat's activity for destruction is driven underground, when the root system is attacked. This fact leads us to face another problem about *juliflora*. Does this attack at the root system cause the branching of stems at ground-level, *i.e.*, bushy habit? It is a well-established botanical fact that, when a root system is exposed or injured, it gives rise to root-suckers or shoots. Troup mentions this in connection with *babul* trees.

To sum up, my theory is that, when a rat gnaws *juliflora* in the seedling stage, the plant develops strong lateral branches. In the case

of older plants the root system is attacked, either killing the plant outright or giving rise to several stems at ground-level due to the injury or exposure of the root system.

This field or antelope rat attacks *babul ban* plantations in Berar, but I notice it is extremely partial to *P. juliflora*, and this pest is to be watched with great care. Rat burrows in *P. juliflora* plantations should be recorded from time to time and injury to plants reported to the Divisional Forest Officer concerned.

About this rat, I give below a valuable note by Rao Bahadur Shrinivasulu Nayadu, I.F.S., in dealing with this pest in *babul bans*:

"R. B. Shrinivasulu Nayadu states that the injury begins when the seedlings are weeded in the rains, but becomes very noticeable when the harvest is over and there is no food in the fields to invite the rats. These animals appear to multiply most freely in the dry season. The deep cracks in the black cotton soil are specially favourable to them since they live in deep burrows. The rats rear their young eight to 12 at a time in nests built two feet above ground in the interlaced branches of *babul* thickets and a knowledge of this fact is useful in helping to reduce their number." (Troup, Vol. II, 430.)

(3) Owing to the peculiarity of the plant mentioned above and the presence of stout thorns, this species is very unpopular with the lessees of combined cultivation. In the second year of its growth it throws out strong lateral branches. Bullocks refuse to plough the land between the lines of *P. juliflora* and labourers do not like to weed near these plants. In the third and the subsequent years plants in favourable localities become so bushy that the field crop is menaced and sometimes it is impossible for men to walk between the lines of *juliflora*. Mr. K. C. Ray, I.F.S., suggested pruning of seedlings with a view to encourage the plant to an upright habit. In my opinion, Mr. Ray's suggestion should be considered and the lessee be allowed to prune *juliflora* so that they may not interfere with his ploughing, weeding and growing of field crops. Pruners which give a clean cut are available in the Calcutta market. They should be purchased and lent to the lessee free of charge for this operation. Agri-silvicultural system is based on mutual co-operation between the lessee and the forest department. If this concession is not allowed to operate to the benefit of the plant as well as of the lessee, the success of this plant under this system is very doubtful. In future, lessees will offer considerably lower prices for such leases if they are compelled to sow *P. juliflora* exclusively We definitely know that *P. juliflora* under combined cultivation is very unpopular for obvious reasons and whether it will fetch the same price as *babul* is problematical. On the other hand, *P. juliflora* is very popular with the subordinate staff. Germination is easy and they have not to worry when plants are one year old, as *juliflora* looks after itself after this period provided the soil is not very shallow and it is weeded for two years.

(4) *P. juliflora* is an evergreen tree; at least it is so in Berar.

(5) I have seen two-year-old seedlings in coupe No. 2, Bhongaon F.S., in flower. Trees three to four years old have seeded as noted by Rai Bahadur D. R. Datt.

(6) In coupe No. 26, where *P. juliflora* plants are six years old, I have seen natural regeneration.

(7) This variety of *juliflora* flowers and fruits twice a year. In coupe No. 26, I found many trees with pods and flowers on the same plant.

(8) Even this upright form has a very short bole with a few more stems branching at ground-level.

(9) In *babul bans* where *babul* does not grow in *chunkheri* (calcareous) soil this species of *juliflora* may be encouraged. It is a mistake to think that *juliflora* will grow in all kinds of poor soil. It is also being tried in Amraoti division with varying degrees of success.

THE GREAT INDIAN RHINOCEROS

By A. N. Roy

(Senior Forest Ranger and Game Warden, Buxa Forest Division, Bengal)

Until recent years, there was a two-horned rhinoceros in Malaya, but it is probably now extinct according to Theodore Hubback, who spent some considerable time looking for one. There remains in Asia, the Great Indian Rhinoceros (*R. Sondaicus*), which is also becoming very scarce but is known to exist in the Nepalese *Terai*, in the Kajiranga Sanctuary of Assam, and in the Jaldapara Sanctuary of Bengal. The latter is 36 square miles in extent, being bounded on the north by the Madarihat-Nilpara Road, on the south by the forest boundary, on the east by the Nilpara-Chilapatta Road and on the west by the forest boundary. Within this area, or in the forest adjacent to it, it was estimated that, prior to 1930, there lived about eighty rhinoceroses but in 1930 and 1931 a number of *Mechis* (also known as *Boros*) came over from the Goalpara district of Assam to join the local *Mechis* and, between them, during those two years, they murdered about 50 rhinoceroses. (In 1932 and 1933 T. V. Dent collected about fifty separate skulls.)

In 1932, thanks to the representations of E. O. Shebbeare, the Rhinoceroses Preservation Act came into being and the above area, known as the Jaldapara Game Sanctuary, was declared a special reserve for the preservation of the rhinoceroses.

The writer was made Honorary Game Warden of this reserve in 1934 and scarcely ever saw a rhinoceros until 1936. The population is now estimated at 60 and it is thought that very few are poached.

Very little is known about the rhinoceros and this sanctuary offers a unique opportunity for observation.

A large bull stands about five feet six inches at the shoulder and is about 10 feet long. The horn is about eight to 10 inches long. The cow is a somewhat smaller animal and her horn is only rudimentary or, in some instances, non-existent. Both sexes are hairless and have heavy folds of skin on the shoulders, flanks and knees which, at a distance give them that well-known "armour-plated" appearance. They are apparently monogamous and pair off for life, but this needs further investigation. The gestation period is thought to be about eighteen months and cows give birth to one calf every three years. Calves are generally born in the spring and are weaned after 18 months.

Like the elephant, the rhinoceros dislikes intense heat and is worried by flies and leeches. He lies up in thick forest during the heat of the day, generally in pools under deep shade or in muddy wallows.

Their food consists mainly of tall grass, water hyacinth and other aquatic plants and their roots. They are also very fond of maize and rice and can do a considerable amount of damage to these crops just before they ripen.

The horn is apparently never used for rooting and is thought to be merely a weapon of offence and defence.

The rhinoceros has no natural enemy in the jungle with the exception of tiger. A calf has been seen which had been badly mauled by a tiger. The rhinoceros having very poor vision, but good hearing, is apt to be nervous of any strange sound and will generally clear off on hearing the human voice. He is not afraid of elephants but does not like them to approach nearer than about 25 yards. He is probably faster than an elephant over short distances and moves noticeably faster than an elephant in shallow water.

The rhinoceros' chief enemy is man and, in this, he is more unfortunate than any other animal for reasons which are based on absurd superstitions. The horn of the male, which is composed of compressed hair, is valued greatly both as an aphrodisiac and as an antidote for various poisons, including opium. Its market value is about 25 rupees per ounce, and a good horn weighs over 60 ounces.

Rhinoceros blood can be sold at two rupees a bottle and urine at the same price. The dried skin and meat are worth about one rupee per pound.

It is easy, therefore, to understand the tremendous value of a dead rhinoceros to any-one who is clever enough to kill one and market the entire carcase. Little wonder that the Game Warden must be about his job day and night to prevent poaching.

The rhinoceros is held in great sanctity by all Hindus living in northern India but, unfortunately, such religious awe is insufficient to afford protection.

HITCHENIA CAULINA (*CHAWAR*) AS A SOURCE OF ARROW-ROOT

BY M. S KHAIRNAR

(Range Forest Officer, Mahableshwar, Satara District)

The scitaminaceous plant *Hitchenia caulina* occurs gregariously on the tableland of Mahableshwar and extends down to the coast on the west. On the Mahableshwar plateau alone its distribution is estimated at over 16,000 acres. Enumeration in a dense area gave as many as 20,500 to the acre.

In the past only the Chinese ticket-of-leave men of the Boxer rebellion appear to have utilised the tubers of this plant for the manufacture of arrow-root. The local villagers do not appear to have taken to it as an article of diet. In normal times the cost of manufacture of commercial stárch was prohibitive.

As foreign starch was not available in the market due to war conditions, the Sub-Divisional Forest Officer, Satara, sought advice from the Director of Industries, Bombay, who, after testing a parcel of 25 lbs. of the tubers, reported that it was "possible to get arrow-root starch from the Mahableshwar tubers. The yield obtained was 7.6 per cent. of the weight of the tubers. The whiteness of the latter portion (about 40—45 per cent. of the total starch) is not up to the foreign sample and the results obtained so far are very encouraging." It must be noted that the tubers were supplied in September, a time of the year when the starch content is obviously on the low side. As the Director expressed his desire to make further tests, a further parcel of 100 lbs. of tubers was sent to him in April, 1942. A brief summary of his report is given below:

100 lbs. of tubers lost through driage, 20 lbs. in transit. The tubers were classified into three size-classes:

Size		*Weight in lb.*	*Moisture percentage.*	*Starch (lb.)*	*Starch percentage.*
Big	..	26	67.41	4.78	18.3
Medium	..	48	67.41	5.4	11.28
Small	..	5.5	70.49	0.6	10.9

The average was 13.58 per cent. out of which 8 per cent. was superior, absolutely white and compared well with starch of foreign make.

Comparative results of arrow-root starch prepared in the laboratory of the Director of Industries and two English samples of well-known brand:

	Laboratory sample	*English "A"*	*English "B"*
1. Moisture percentage	10.40	12.90	11.90
2. Ash percentage	0.50	0.28	0.42
3. Water-soluble matter percentage ..	0.14	0.41	0.19
4. Ether-soluble matter percentage ..	0.10	0.70	0.64
5. Viscosity at 25° C. in seconds, that of water being 16 seconds	18 Secs.	21 Secs.	17 Secs.
6. Acidity expressed as C.C. of N alkali required to neutralise acid in 100 gms. of starch	1.342 c.c.	0.732 c.c.	1.830 c.c.
7. Starch contents by difference percentage	88.86	85.71	86.85

A private company was then given an area of 100 acres to see for themselves how far it would be profitable to manufacture starch. In the subsequent auction of the whole area they purchased the contract for two years for Rs. 22,004.

The preparation of the arrow-root is very simple. The tubers are dug up, washed in water to remove all soil adhering to them, the fibrous roots are chopped off and the tubers are pressed one by one against graters. These graters consist of wooden rollers mounted on trestles and kept turning round by hand power. The rollers have grating sheets nailed to them. The grated material falls into a trough through which water is constantly flowing. The tuber is soft enough to be easily grated. The grated material is carried into large vats where it is thoroughly washed, once sieved through cloth, and washed a second time, the whole process taking three days. On the fourth day the arrow-root is ready for sun-drying, which is carried out by spreading it evenly on clean sheets spread over iron sheets. With three or four washings it is expected that the arrow-root will be perfectly fit for human consumption.

Even with only two washings the starch has a considerable range of utility in the manufactures of Bombay, particularly for glues and sizing, and it is hoped that a great deal will be heard of this forest product in the future.

THE PROBLEM OF *SAL* REGENERATION IN MAYURBHANJ

BY K. N. R. NAIR, B.A., B.Sc. (EDIN.)

(*Working Plans Officer, Mayurbhanj*)

The series of articles that used to appear in the *Indian Forester* on the above problem was both interesting and illuminating. But it stopped all at once to the great disappointment of many forest officers like myself, who are "yearning to quench their thirst from the fountain of knowledge." It is impossible that the problem has been solved, and the writer hopes that forest officers of the several provinces and states of India will publish the results of their experiments in the *Indian Forester*.

The writer of this note got his "inspiration" from two articles on the above subject published in the *Indian Forester*, sometime in 1942, one by Mr. R. N. De, now Conservator of Forests, Assam, and the other by Mr. M. C. Jacob, Deputy Conservator of Forests, Assam. Experimental plots were laid out in several places with varying aspects and elevations to study the effect of the canopy, weeds, grass and fire on the regeneration of *sal*. The results obtained during the last two years are summarised in this article.

I need not describe in detail the general ecological factors available in Mayurbhanj, as this has already been done in an article entitled "The Sinecological study of the forests of Mayurbhanj."* However, for the convenience of readers, I shall give a very brief outline of the general climatic factors of the State affecting plant growth. The climate is a near approach to moist tropical, with a rainfall of 70 to 98 inches per annum, and temperature varying from 45 to 115°F. The soil is mainly lateritic in origin, mixed with phyllite, gneiss and schistose rocks.

Although Mayurbhanj has got extensive *sal* forests—more than 2,000 square miles—the natural regeneration of the species is, on the whole, very poor, and in several places it is totally absent. Every year there are extensive ground fires, and up till now the absence of advance growth was attributed to fire. The first experiment was started to see how far the top canopy was responsible for the absence of regeneration. A five-acre plot was selected at an elevation of about 1,800 feet and the

* *Indian Forester*, Vol. LXX., No. 8, dated August, 1944, page 257.

small trees, such as *Phyllanthes emblica, Cleistanthes collimus, Bauhinia malabaricum* and *Nyctanthes arbortristis,* which formed a lower canopy, were removed. The floor was almost clean except for a few *sal* "whippy" seedlings here and there and one or two *Xylia xylocarpa* seedlings. There were in all 423 trees in the plot, out of which 382 were *sal*, varying from 18 inches to six feet in girth. The area was rigidly fire-protected during summer and, just after the monsoon, it was noticed that the floor was literally covered with *sal* seedlings, one to three inches in height.

In a nearby area, an almost similar plot, but with the top canopy partly open, was selected. Here in an area of five acres there were 294 trees in all including 206 *sal*. The lower canopy was left intact, and fire was kept out during summer. At the close of the monsoon, it was seen that comparatively very few seedlings had come up in this area.

The second experiment was started with a view to find out the effect of weeds on the natural regeneration of *sal*. The common weeds met with are *Milletia auriculata, Combretum decandrum, Croton oblongifolius, Holarrhena antidysenterica* and *Colebrookia* spp. In a five-acre plot containing 316 trees, of which *sal* formed 209, all the weeds were removed and the area kept under fire protection during summer. In the following September, when this plot was again inspected, there was profuse regeneration of *sal*, although coppice shoots of *Milletia auriculata* and *Combretum decandrum* had also come up. In a control plot very near to this, where the weeds were not removed, it was seen that not even one new *sal* seedling had appeared during the year.

In the third experiment the problem was grass—mainly *Saccharum* spp. There was a dense growth of grass and, apart from the fact that there was no chance of a small seedling succeeding to come up, even for those few seedlings that were already over 18 inches in height, the struggle for existence appeared to be very great. A five-acre plot, with 287 trees in all, the *sal* numbering 264, was selected at an elevation of about 3,000 feet. The problem was how to check the growth of grass. Cutting it was a costly operation, while burning would only encourage a more luxuriant growth. Finally it was decided to thrash it to the ground level by sticks, hoping that it would rot during the rains. The area was very vigilantly watched during summer and fire was kept out. It was an agreeable surprise to me in the September following that there was fairly good regeneration in this area despite the fact that a sparse growth of grass was also found. This grass could easily be trampled down to allow more room for young seedlings.

The last experiment was about fire, generally believed to be the greatest evil of all. Fire in the hills usually starts by the end of March and it was decided not to do any early burning in the control plot. An area of five acres containing 389 trees—*sal* being 321—was selected, cleared of all weeds and kept under strict fire protection. In the control plot which contained 371 trees including 323 *sal*, all the undergrowth was apparently destroyed by fire early in April. The year 1913 marked a very heavy fruiting of *sal* and just after monsoon it was seen that, while the regeneration of *sal* was good in the fire controlled plot, it was tolerably fair in the other plot too. But in the latter the weeds, particularly *Milletia auriculata* and *Croton oblongifolius,* were growing so very luxuriantly that it was impossible for the young seedlings to get any light.

Summarising the results so far obtained it can be said that *sal* regeneration is possible even with an unbroken top canopy, but the seedlings will not tolerate a lower canopy of 10 to 15 feet from the ground. The greatest hindrance to the establishment of the young seedlings is the "weeds," particularly climbers such as *Milletia auriculata* and *Combreteum decandrum* and the "battle" is half won if these are checked. Fire by itself is not such a great danger as many consider it to be, but it is the luxuriant growth of weeds and grass which follows that does the harm. Continued fire protection for a period of more than five

years is harmful inasmuch as it induces the growth of certain evergreen species which suppresses *sal*. In short, proper checking of the weed growth till the seedlings are established, clearing of the lower canopy if present and strict fire protection for short periods of three to five years will together form the clue to the problem of *sal* regeneration.

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FLOWERING OF *BAMBUSA ARUNDINACEA* IN ORISSA.

By J. W. Nicholson, C.I.E., I.F.S.

(*Conservator of Forests, Orissa*).

In 1912 *daba* bamboos (*Bambusa arundinacea*) flowered over part of Puri and most of Angul Division. Over these parts a few clumps flowered sporadically in 1944. In November, 1944, while on tour with the Divisional Forest Officer, Angul, it was noticed that the *daba* bamboos were becoming leafless whereas usually they do not shed their leaves until two months or so later. In view of the fact that the life cycle of *daba* bamboos averages 32 years this unusual phenological occurrence seemed to portend gregarious flowering. This has since happened. We decided that full advantage must be taken of this flowering and the action we propose to take may be of interest to other provinces and to states.

Before describing these proposals it is necessary to explain the term "interplanting." About 12 years ago, while Divisional Forest Officer, Palamau Division in Bihar, I experimented with the planting of teak in lines 24 feet apart and 6 feet apart within the lines in coppice coupes two years before they were due to be felled. No weeding or tending was done until after the coupes were felled. The idea of such planting, which we have since decided to term "interplanting", was not to form teak plantations but to introduce teak where other valuable species did not naturally exist. The early results of these experiments were promising, though to what extent they have been continued with in Bihar I do not know. At any rate on being posted to Orissa as Conservator of Forests in 1936, I decided that we should continue the experiments not only in coppice coupes but also in selection coupes. Experiments in the latter were carried out on a small scale in Angul Division, interplanting being done in lines 33 feet apart and, firstly at 6, and latterly at nine feet apart within the lines, no planting being done under valuable species or very close to clumps of *Dendrocalamus strictus*. The early results were again full of promise. Early in 1938 gregarious flowering of *Dendrocalamus strictus* bamboos occurred in most of the damper valleys of the division. I decided that we ought to gamble on the success of large-scale interplanting and gave instructions to the divisional forest officer to interplant flowered bamboo areas on the largest scale possible in May-June, 1939. Unfortunately the divisional forest officer did not obey these instructions and I was that planting season on long leave. On my return from leave I instructed the divisional forest officer to interplant as big an area as possible in 1940. This was done and flowered areas left over were all interplanted in 1941. A photograph of this interplanting is reproduced opposite page 161 of *Indian Forest Record, Volume* 5, *No.* 2. Owing to the fact that interplanting was done from one to two years too late; to an insufficiently developed technique; to occasional fires; and to damage from wild animals, the results have not been as good as might have been the case. Tending operations have been heavier and more prolonged than should have been necessary. However, there is hardly any doubt that the gamble will come off and that financially and silviculturally the interplanting will prove a great success. In consequence of this optimistic forecast teak interplanting of mixed forest selection coupes on soils suitable to teak is being made a prescription of the working plan now under revision. Teak regenerates naturally throughout most of Orissa and we expect that ultimately our Angul mixed forests will be mainly teak with an underwood of *Dendrocalamus strictus*.

In Angul *daba* bamboos occur mixed with *sal* in a particular type of forest which extends from Angul through some of the Eastern States to Puri Division. The main *daba* forests, however, in Angul occupy damp valley bottoms the overwood consisting largely of miscellaneous species of little value. The *daba* bamboo has practically no commercial or local value. It is therefore our policy to establish regular teak plantations in these *daba* valley areas which are usually eminently suitable for producing Quality II teak. In the *Mals* of Puri Division we get the same *sal-daba* type

of forest on certain soils. Elsewhere in the damper areas of the *Mals daba* occurs mixed mainly with evergreen species, but the *daba* is not so dense as in the Angul valleys. These *daba* mixed forest areas are gradually being converted into teak by regular and toila plantation methods. In Puri *daba* has a commercial and local value though in *sal* forests and teak plantation areas its nuisance value exceeds its market value. The supply is in excess of the demand and a reduction of supply will not affect revenue or the interests of the local population.

To turn this flowering to the best advantage instructions have been issued on the following lines:—

(1) In both divisions an effort will be made to fell before the seed ripens all *daba* clumps occurring in *sal* forests or in teak plantation areas. In Puri Division it is hoped that purchasers for such bamboos will be found: in Angul Division the work will have to be done departmentally at a considerable cost. It is felt that the expenditure will be well worthwhile as we will save much expenditure and labour on tending costs during the next life cycle of the bamboos should they be allowed to regenerate. Early burning of the felled-over areas will be carried out in 1946 as soon as conditions permit and this operation will be followed by tending operations of the *sal* and teak.

(2) In Angul Division no regular plantations of teak in *daba* areas will be made this year. Instead all efforts will be made to interplant the maximum area of flowered *daba* that stump and labour supply permit giving preference to areas where the *daba* forest does not exceed 10 acres in extent—our minimum unit for regular plantations. In the areas so interplanted the flowered clumps will be fired individually as soon as they are dry enough. We hope this will be the case by February, 1945. The teak will then be tended in the usual way by removal of double leaders, pruning etc. In 1946, probably in 1947, and possibly in 1948 we will switch over from interplanting and concentrate on regular planting in flowered areas of 10 acres or more. We hope that it will be possible to burn the *dabas* standing by mass instead of individual firing, and that the severity of the fire will be such as to kill out much of the regeneration. After 1947 or 1948 regular plantations will have to be suspended until the *daba* bamboos reach a size capable of giving a good burn. During this period we will concentrate on interplanting selection felling coupes.

(3) In the Puri Division Mals toila plantations are being done in a locality where *daba* is not due to flower and the usual toila programme will be continued with. There is only one centre where regular plantations are being made. These plantations are in the vicinity of where the limited local labour lives. We have been unable through labour difficulties to plant more distant areas which should be capable of growing very good quality teak. Interplanting requires no labour during the rainy season. This year we will do no regular planting and concentrate on interplanting these more distant *daba* areas, the same procedure being subsequently followed as stated above for Angul interplanting. From 1946 the regular plantation programme will be followed.

Interplanting as described above—it must not be confused with old methods of line planting—has not before been tried in flowered *daba* areas. We do not know to what extent the teak will be able to compete with *daba* regeneration but, from what I have seen of the growth of young *daba* clumps from sporadic flowering, it should be able to do so without excessive tending operations, provided the stumps are put in this year. It is possible that the teak could compete successfully if planted in 1946 but tending operations would almost certainly prove costly. That is why interplanting is not contemplated after this year though we may do some on a small scale in Puri Division in 1946 and take a risk. Readers will think we are taking a big risk over interplanting in 1946. Perhaps we are, but our costs of raising teak stumps (by rab nursery methods) are lower than elsewhere in India—under Re. 1/- per 1,000 at pre-war wages. Even at current wages, including nursery costs, interplanting should not initially cost more than 12 annas an acre. The gamble appears to be a good one, and our interplanted teak horse ought to romp home a good winner of stake money.*

*Since the above was written it has been decided to attempt to burn flowering clumps individually during March and early April this year in localities where we want the bamboos eradicated. If these attempts prove successful burning will replace departmental cutting.

AFFORESTATION IN ATTOCK SOIL CONSERVATION DIVISION.

By Amir Ahmad Khan

(*Divisional Forest Officer, Attock Soil Conservation Division, Punjab.*)

Introduction.—Afforestation of extensive bare areas—Government forests and private waste lands—in this division is very urgent problem and requires immediate attention. Absence of vegetation has resulted in most destructive erosion and reduced the fuel and fodder resources of the villagers. *Zamindars* (landlords) are now voluntarily closing their waste areas and handing these over to Forest Department for management from counter-erosion and afforestation point of view. It is therefore imperative that we should study and work out a satisfactory and reasonably cheap technique for afforesting these areas.

Object of this note is briefly to describe the technique being followed and suggest problems which require systematic study.

Limiting factors.—A brief description of the following factors will be useful for proper appreciation of the problem.

1. *Rock and soil.*—The following tree types are met with :—

(*a*) *Limestone.*—This is common in the central part of the district and no soil is formed when rock is composed of pure carbonate of lime.

(*b*) *Sandstone.*—This is the commonest rock and is met with over greater part of the district, particularly in the south.

(*c*) *Slate and shale.*—This is met with in the northern parts adjoining Frontier hills.

Soil varies from pure sand to stiff clay. Pure sand of the desert type is met with in two vast areas, *viz.* one round about Campbellpur and other near Jand in the south-west of the district. Rest of the area consists of either heavy clay or light loam soil. Greater part of the area available for closure and afforestation consists of denuded hillocks and slopes with a shallow deposit of soil.

2. *Climate.*—Climate of the tract is extremely hot in summer and bitterly cold in winter. Maximum shade temperature may go up as high as 119 °F in June and minimum may come down as low as 27° F. in January. Hot winds in summer and bitterly cold winds in winter are very common.

(*a*) *Rainfall.*—Total annual rainfall as recorded at Campbellpur is 24 inches and average, by quarters, for the last 17 years is given below :

Jan., Feb., March	.. 6·86 in.
April, May, June	.. 3·00 in.
July, August, September	.. 12·07 in.
Oct., Nov., Dec.	.. 2·08 in.

Rainfall is of cloud-burst intensity and very erratic in nature. Heavy showers do not allow much percolation in the soil and a rainy day followed by weeks of cloudless weather is of very little benefit to plants.

(*b*) *Drought.*—Autumn and summer droughts take heavy toll of young seedlings and are the main limiting factors in the establishment of plants.

(*c*) *Frost.*—Severe frosts are experienced occasionally and even the hardy indigenous species are badly damaged in early stages.

3. *Grazing, browsing and damage by wild animals.*—Grazing and browsing by domestic animals and damage by *urial* and in some cases by porcupine act as limiting factors.

Present technique.—The fundamental principle in the present-day afforestation technique is the conservation of moisture—the main limiting factor—and every effort is made to achieve this object. Following technique is followed :—

1. *Contour trenching.*—Contour trenches 10 ft. ×1 ft. ×1 ft. are dug up and sowing is done only along these trenches. No patch or broadcast sowing is attempted as due to lack of moisture seedlings die away in the first drought.

2. In the past sowing used to be done on berm of trenches and it was experienced that in years of drought mortality was very high. Nowadays sowing is done both inside the trench and on the berm and results show that in the first year seedlings in the trench put on nearly double the growth of seedlings on berms and mortality is also very low in the former case. In this division sowing inside the trench is now being followed as a standard practice.

3. *Hoeing.*—Hoeing to produce mulch and reduce surface evaporation was tried this year (1944) during the autumn drought. Work was done on a limited scale as an experiment and condition of seedlings on hoed trenches is much better than on unhoed trenches. Under orders from Director, Soil Conservation Circle, Punjab, controlled experiments are being laid out to study effect of (*a*) Hoeing (*b*) Artificial mulching by a 4--6 inch thick layer of grass and (*c*) control on seedlings during coming summer drought. The results of the experiments are yet to be seen but there is no doubt that any operation which can help to conserve moisture will contribute a great share in the successful establishment of seedlings.

4. *Contour ridging.*—Under orders from the Director, Soil Conservation Circle, Punjab, contour ridging to hold up and conserve every drop of rain water is being carried out. It is too early to report on the results but it is certain that the measure will go a long way in successfully conserving the rain water.

5. *Choice of species.*—Drought and frost resisting species are given preference over others. *Phulai, kikar,* mesquite, *beri* and *bakain* are being tried. *Butea frondosa* has not been tried but is expected to do well and will be tried next year.

6. *Shisham planting in sandy nala beds.*—The standard practice of using 9 inch root and 3 inch shoot length in stumps has been replaced by 18 inch root and 6 inch shoot. The object is to enable the root to reach deeper down into moist layers and be safe from the effect of drought in the first year of growth. Longer shoot is meant to protect stump from being buried under moving sand.

Proposals for future research work

1. *Comparative study of the effectiveness of various moisture conserving methods on the growth of plants.*—Properly laid out experiments are required to study the effect of various moisture conserving methods on the success of afforestation work. Soil sampling will also be required to study the moisture content of soil under various treatments. Following treatments are suggested for study :—

(*a*) *Contour trenches of various sizes.*
(*b*) Contour ridges of various sizes and at varying distance.
(*c*) Comparison of berm sowing and sowing at the bottom of contour trench.
(*d*) Effect of hoeing, grass covering and other methods of mulch production as compared with control.

2. *Afforestation of desert areas and fixation of shifting sand.*—Extensive privately-owned desert area is met with in the division but no systematic attempt has been made to afforest it. Research to find out suitable species for this area and to work out their planting technique is urgently needed.

3. *Fixation of shifting sand.*—*Kana* (*Saccharum munja*) planting along contours has been tried to fix up sand and protect cultivated fields from hot dry winds. More research is needed to study the effectiveness of other indigenous and exotic grasses. Trial of the following species as a wind belt against hot dry winds and shifting sand is also suggested :

(*a*) *Tamarix articulata.*
(*b*) *Zizyphus jujuba.*
(*c*) *Vitex negandu.*
(*d*) *Zizyphus nummularia.*
(*e*) *Salvadora oleoides.*
(*f*) *Capparis aphylla.*

4. *Effect of wind belt on the yield of cultivated crops.*—There is a general feeling among the *zamindars* that wind belts usurp the moisture from fields for a width of 15—25 feet along the belt and yield of crops is much lower than in the fields without belts. Moisture study experiments are required to find out the effect of wind belts on the moisture (*a*) near the belt (*b*) in the centre of the field. It is just possible there may be slight decrease in moisture near the roots of the plants forming the belt but centre of the field being protected from hot winds will have more moisture. We have no statistical information on this subject, and it will be very useful to carry out experiments in this direction. Trenching along wind belt can reduce loss of moisture in the wind belt.

EARLY SPACING IN CHIR (PINUS LONGIFOLIA).

By The Central Silviculturist, F.R.I., Dehra Dun

An interesting experiment in the early spacing of *chir* has just been concluded in the demonstration area of the Forest Research Institute, Dehra Dun. In general, *chir* is regenerated naturally and the regeneration comes up very thick indeed. Early spacing is necessary particularly to reduce the fire danger and secondly to give the best stems good healthy conditions in which to grow. This early spacing is however often either not done or greatly delayed because usually these young thinnings are not remunerative.

The plantations at New Forest are raised by dense sowings in lines 6 feet apart and usually come up very thick with several thousands of plants to the acre. In addition under present conditions all thinnings are useful to us as fuel for the utilisation branch boilers, for charcoal, and for paper.

The experiment was started in 1935 in a dense *chir* plantation 5 years old. Nine plots each 48 feet by 40 feet were selected and each had a surround which was treated in the same way as the plot. These plots were arranged in three initially comparable sets of three plots each.

The treatment applied was reduction of stems to (B) 545 trees per acre, (A) 800 trees per acre and (C) the unthinned control. It was originally intended to leave only 400 stems per acre in the heaviest thinned treatment but a trial of this in another area showed it as too heavy for the age of 5 years.

The initial condition of the plots after thinning was

Treatment.	B	A	C
Crop diameter in inches ..	1.9	1.9	1.9
Crop height in feet ..	9.3	9.3	9.4

The experiment was finally measured in 1944 when 14 years old when the treatment A (545 trees per acre) appeared to require further thinning as competition in it was beginning to become serious.

The crop measurements were as follows:—

Measurements in 1944 at 14 years old. Mean of 3 plots per treatment.

Treatment.	B 545 trees per acre.	A 800 trees per acre.	C Unthinned control.
Crop diameter in inches.	6.5	5.8	3.9
Crop height in feet ..	34	34	30
Number of trees per acre	538	818	2697
Number of trees per acre containing stem timber	68	41	8
Stem timber volume in c.ft. per acre ..	169	70	7
Total volume per acre in c.ft. ..	2276	2696	3669
Average crown length in feet ..	18	17	13
Average crown width in feet ..	11	9	7
Number of branches per tree in the bottom 8 ft. of bole .	Dead 17	15	12
	Green 0.1	0.2	0.0

The measurements, however, do not show the form or healthi-ness of the crops and to the eye, the unthinned control was of poor form and in a very unheal-thy condition.

The measurements show that the spaced crops have benefited very greatly by the early thinning provided they are intended to be grown on a fairly long rotation to produce comparatively large timber (as is usually the case in India). It is to be noted, however, that if they are to be grown on a fairly short rotation for a special purpose such as pit props or paper pulp the early spacing has not been beneficial as the crop volume is much the greatest in the unthinned plots. This is of course provided that the individual poles have reached or will reach the required diameter of the final product.

It is of particular interest that the heavy thinning has not produced a thick crop of persistent branches as was expected. The boles of the unthinned crops are very little cleaner than those of the heaviest thinned crops.

The figures are of interest as in England as a wartime measure very many conifer plantations have been clear-felled for pit props

etc. at a very early age and the majority of these had never been thinned. There is little or no data of what the pit prop outturn would have been had the plantations been thinned. It is possible that in the future short rotation conifer crops may be grown for these special purposes and very little data exists on the effects of early thinning.

TECHNIQUE OF SAL TAUNGYA IN THE GORAKHPUR FOREST DIVISION (U.P.).

BY KHAN BAHADUR M. Z. HUQ, I.F.S.

(*Divisional Forest Officer, Gorakhpur Forest Division*).

In this division the clear felling areas are sold in July and the fellings and conversion generally start soon after the auctions are over. The forest contractors finish their work and finally leave the area by about the end of April.

The fields are then distributed amongst cultivators of proved merit in the month of April and May, each cultivator getting half to one acre according to his working capacity. Tenants coming from distant villages generally stay in their plots where they build their huts, but tenants from neighbouring villages do not reside inside the area as they often own some fields in their villages as well. Such cultivators are given only half acre each. In Tilkonia and Pharenda Ranges, there is such a great demand for land that a charge of Rs. 2/- per acre is levied on the tenants in the beginning for the full period of the 5 years' lease as *nazrana*, whereas in other ranges of the division no such *nazrana* is realised. The cultivators then clear their fields of all scrub and weeds and burn the stuff along with any debris left over by the forest contractors. This operation must finish by the third week of May and then the cultivators prepare their fields to sow the *kharif* crop consisting of maize or other local crops like *tangun*, *madua*, *kodo* etc. and in low-lying areas paddy, soon after the first showers of rain have fallen in early June. This crop is harvested in October and then *rabi* crop consisting of *lahi* (rape-seed), or of wheat, barley, gram, peas etc., is sown. This crop is completed by the following March. Raising of sugarcane is absolutely prohibited.

During the cold weather the cultivators generally dig out large stumps from their plots and burn them into charcoal for selling it in the market to add to their income.

Soon after harvesting the *rabi* crop, the cultivators begin to dig *nalis* (trenches) for forest sowings. The distance between the sowing lines had been gradually reduced from 18 ft. in 1922 to about 10 ft till some time ago; but since 1943 it has been reduced to about 7 ft. so that the forest canopy may close up early and thus reduce the period of exposure of the forest soil and also minimise the danger of grass invasion after the cultivators would leave the area. These close lines are also expected to help against the inherent defect of forking in the *taungya* plants.

In the past the *nalis* used to be dug box-shaped 16 inches deep and 16 inches wide at top and bottom and the dug earth was piled on one edge of the *nali* without allowing it to weather properly. It has, however, been realised that raising of *sal* on the deep loose and rather dry soil of such *nalis* is not very successful because (*i*) this loose soil becomes comparatively poorer as the earth of the upper six inches layer containing humus is mixed with the bottom 10 inch layer of poor quality; (*ii*) during the following dry weather all this loose soil gets dried up, and it cannot draw up natural moisture through capillary action from the compact soil below or at sides, as it had not sufficient time to bind itself with it; and (*iii*) the seedlings instead of developing straight long and sturdy taproots, tend to develop bushy side-roots with the result that even these secondary roots are not able to penetrate into the compact soil during the short wet period of about 4 months and draw moisture themselves from below the loose soil. There is thus a huge mortality on account of drought.

Hence the *nalis* are now dug only about 9 inches deep and 9 inches wide at the top with sides narrowing down to 5 inches wide at the bottom *i.e.* more or less following the shape of a hoe with which they are dug. The earth from the *nali* is scattered on both sides of the *nali* for better weathering before it is put back after a thorough drenching in the following

June. Besides other useful savings as mentioned later, there is thus much less labour (about one-fourth) involved in this new method, and much less mortality occurs among *sal* seedlings as the soil is now comparatively richer and the seedling is able to develop a strong taproot which being guided by the tapering sides of the *nali* penetrates straight into the compact soil below, and starts drawing up the required moisture from the subsoil before the dry season sets in. We are in this way nearer to the method of nature and in fact are helping her action better than under the old method of deeper and wider *nalis*.

The digging of *nalis* must be completed by the middle of May at the latest so that the earth may have sufficient time to weather before it is filled back into the *nalis*. It is preferable if the cultivators are made to dig *nalis* before the end of March when the weather is not very hot and cultivators have little to do in their fields. At this time the cultivators can put in more labour, the soil is not very hard, and the dug earth gets plenty of time to weather before sowings are done. But where the field crops are still standing the digging work at this time is not enforced.

Till 1941, the practice was to begin filling the *nalis* soon after the digging work was completed and the sowing of *sal* seeds was done at the first heavy shower of rain. The seed was sown in three rows on the same line, wing to wing apart, and at depths of 1 inch, 2 inches and 4 inches in respective rows. Sowing in two rows with seeds at depths of 1 inch and 2 inches was to be completed in the whole area in one operation, and then sowing of the row with seeds at 4-inch depth was taken up. This practice was adopted because it was considered that if there were a dry break in the monsoon, the seeds sown shallow might deteriorate, and those sown deep would still germinate and stock the area. This practice, however, caused a huge wastage of seed and labour and was further attended with a serious drawback of both overground and underground competition amongst the seedlings, as often all the seeds germinated due to high germination percentage of *sal* and the resulting crop has been generally very stunted, malformed and bushy.

The new method now introduced is to fill the *nalis* only after a heavy downpour of rain when all the *nalis* are once fully flooded and the water has completely soaked in them. Thereafter the bottom of the *nalis* is raked to a depth of about 3 inches, thus breaking the crust of earth formed after the water has soaked in, and also making a connection with the capillary tubes in the subsoil. The weathered earth lying scattered on either side of the *nalis* is then intimately mixed, well pulverised, and filled into the *nalis*. The seed bed line is then raised into a ridge about 6 inches above the ground level to allow for better æration, to accelerate germination, and to discourage development of side roots. This high ridge also allows for keeping the bed lines from sinking below the ground level while they settle down during the rains. The *sal* seed is then sown in one row only about 2 inches deep and 4 inches apart along the centre line of the ridge. The seedlings germinating on the *nalis* so prepared have successfully been found to tide over a period of even a fortnight without rains following the sowings. The seedlings send their taproots deeper down into the subsoil and put on better and healthier growth and there is much less root competition than was the case with the plants raised too close together on *nalis* of the old excessive soil working method. The last rainy season (1944) was about the worst for many years in the past, but we had comparatively very few casualties to beat up throughout the seven ranges of the division. It may, however, be carefully noted that *sal* sowings should not be started before the 10th of June, the best time being between the 15th and 20th June when the best quality of mature seed is still available and there is less risk of long rainless intervals following the sowings.

Sowing of *jamun* with *sal* in areas suitable for *sal*, should be avoided as *jamun* offers a very detrimental competition both underground as well as overground to *sal* and it becomes almost impossible to keep down *jamun* against *sal* for many years of subsequent vigorous growth. *Jamun* should, therefore, be sown in low-lying areas only which are unsuitable for *sal*. Also during the subsequent beating up operations, *asna*, *mahwa*, teak, or *siris* should be given preference to *jamun* in *sal* areas.

When the forest sowings are completely finished, the cultivators are allowed to sow their crops in between the lines. During the rains the tenants have to keep the lines clear

of weeds and grass, and replace casualties, if any, during the same season. Beating up of long line of casualties on the old *nalis* in the following year never gives good results unless fresh *nalis* away from the old ones are dug and sown in the same manner as in the first year.

Under no circumstances should paddy or any late-reaping or water-tapping crops be allowed to be raised during the first two years of the forest sowings except in some low-lying areas only. There is, however, no restriction on raising any such crops in the preliminary areas or in the areas of three-year-old forest plants. In the fourth and fifth years *i.e.*, when the plants are 3 to 4 seasons old, the cultivators have very little to do in respect of our plants and may leave the area for a new one, but before they leave they are made to sow *arhar* (*Cajanus indica*) in between the lines. During March and April, when the *arhar* crop is ready, they are allowed to pluck the fruits only and leave the plants standing. This is done because *arhar* keeps alive for 2 or 3 years, and it acts as a soil cover, protects the *sal* plants from frost, and prevents the invasion of grass and weeds till the forest canopy is more or less closed up. Moreover *arhar*, being a leguminous plant, improves the soil.

In case the cultivators wish to go away earlier than they are due to leave the area, or fail to sow their crops of *arhar* while leaving, then they are made to hoe up the soil in between the lines before they go. This digging up of soil discourages grass and helps the *sal* plants to put on better growth.

When the *sal* crop is 4 years old the first thinning is carried out departmentally. The healthy plants are spaced approximately 2 ft. apart and those in between are cut out. Thereafter the crop is thinned at five years' intervals till it is 30 years old and then at 10 years' intervals. This operation of thinnings, if carried out intelligently according to the requirements of each crop, gives immediate response and insures proper growth of the standing plants.

II. A further development in the practice of taungya.

It has been observed that *taungya*-grown plants do not generally produce good and clean shoots, in their early stages. They develop twisted stems generally with two or three leaders. This is perhaps due to the *taungya* plants being too much exposed on two sides of the lines. Such defects are not so common in the naturally-grown coppice crops. We had, therefore, laid out three plots in 1941-42 in 5, 10 and 18-year-old *sal taungya* crops respectively, in which we had cut back alternate lines to see if the resulting coppice shoots would be free from such defects. This experiment has given very promising results and we therefore subsequently cut back completely, and burnt, a few more *taungya* areas of defective growths which have now given beautiful coppice shoots.

Further, in some cases the *taungya* has not been an unqualified success and our forest plants have failed to grow up well, with the result that grass has monopolised such areas to a large extent. It has, therefore, been considered desirable that as many original coppice shoots as may be available in the clear-felled areas should be retained instead of being destroyed as hitherto, and further regeneration of *sal* obtained by *taungya*, on *nalis* which need not be continuous or so close to each other as under the simple *taungya* system. This method has thus further economised labour on digging and sowing works and the cultivators have now been growing their crops in between the intermittent *sal* lines and the scattered coppice shoots, for the last two years without very much trouble especially in view of the new labour-saving shallow-*nali* method. During this period both our *taungya* plants as well as the coppice shoots have grown very well indeed under the prompt tending by the cultivators. It is proposed that when the forest crop including coppice shoots is five years old, we should cut it all back and burn and then get a new coppice crop which should be free from the usual defects of the direct *taungya*-grown plants. Thereafter we would follow our regular programme of judicious cleanings, climber cutting and thinnings to insure complete success. Of course, the growth of coppice shoots from different-size stumps would again be uneven but, after all, under the natural shelterwood regeneration system, the ages of *sal* plants, both of seedling as well as coppice origin, vary from a few years to over 20 years in the same regeneration area, and it has been established already in this division that there remains not a very appreciable difference between the *taungya sal* and the coppice *sal* in respect of its growth in the course of 25 to 30 years, as seen in Coupe 3,

West Lehra (Pharenda Range), where the *taungya* crop of 22 years in age is nearly catching up the coppice crop of about 23 years. Almost similar results are also noticeable in the 10 to 15-year-old coppice and *taungya* crops in Lachhmipur Range near Tehrighat.

We have thus developed a new *taungya-cum*-coppice method in this division which is a great improvement on the simple coppice system under which we used to fill up the blanks by carrying out expensive departmental plantations of miscellaneous species of doubtful utility and precarious success. Also under this new method there is much less deterioration of forest soil by exposure than under simple *taungya*, and the resulting crop should look more like a natural forest after it has been once coppiced as mentioned above. Moreover, under this method chances of frost or grass invasion are eliminated to a great extent and, above all, the existence of a forest crop, even if the *taungya* tenants failed to do their job properly would be insured.

This new *taungya-cum*-coppice method has been successfully tried in Gularia (Lachhmipur Range), and is being extended to other areas, especially where there exists a fair amount of coppiceable material.

Finally it may be mentioned that this division had to offer the largest supplies of war timber, *ballies* and firewood in the Eastern Circle during the last three-and-a-half years, which involved large additional clear-fellings and, but for the above new method of *taungya*, we would not perhaps have been able to regenerate such large areas extending over thousands of acres so successfully in the midst of the intensive war effort.

SLEEMAN'S "SILVER TREE OR KULPA BRIKSHA."

By V. S. Rao, I.F.S.

(Divisional Forest Officer, Dacca-Mymensingh Forest Division, Bengal)

and

S. K. Sen

(Department of Biology, Dacca University.)

The name of Colonel Sir William Henry Sleeman is well-known to students of Indian history as a distinguished official in the service of the East India Company during the first half of the nineteenth century. Born in August, 1788, he entered the Bengal Army in 1809 and became Superintendent of Thuggee operations (initiated by Lord William Bentinck) in 1835 and Commissioner for suppression of Thuggee and Dacoity in 1839, having his head-quarters at Narsinghpur in the Sagar and Narbada territories, now included in the Central Provinces. He was Resident in Gwalior from 1843 to 1849 and at Lucknow from 1849 to 1856, *i.e.*, the year preceding the Sepoy Mutiny. He died at sea on his way home in February, 1856.

Sleeman was not only a tactful and able administrator, who helped in bringing peace to the country by exterminating the organised bands of murderers and robbers known as Thugs, but he also made his mark as a writer. His *Ramaseeana* appeared in 1836; in 1844 he brought out his *Rambles and Recollections of an Indian Official;* and a work entitled *A Journey through Oudh* was published posthumously in 1858.

Chapter XII of *Rambles and Recollections* contains an amusing story in regard to a tree which the writer calls "The Silver tree or kulpa briksha." This is quoted below *in extenso*[1] to satisfy the curiosity of the reader:

CHAPTER XII

The Silver tree, or kulpa briksha—The Singhara, or trapa bispinosa and the Guinea worm.

* * * * *

[Between Jubeyrah and Hurdooa, the next stage, we find a great many of those large forest trees called kullup, or kulpa briksha (the same which in the paradise of Indra grants what is desired), with a soft silvery bark, and scarcely any leaves. We are told, that the name of *Ram* and his consort *Seeta*, will be found written by the hand of *God* upon all*. I had the curiosity to examine a good many in the forest on both sides of the road; and

1. The spelling and punctuation found in the original are strictly followed in this extract.

*The real kulpa, which now stands in the garden of the god Indra in the first heaven, was one of the fourteen rarities found at the churning of the ocean by gods and demons. It fell to the share of Indra.

found the name of this incarnation of Vishnoo written on every one in Sanscrit characters, apparently by some supernatural hand; that is, there was a softness in the impression, as if the finger of some supernatural being had traced the characters. Nathoo, one of our belted attendants, told me, "that we might search as deeply as we would in the forest, but we should certainly find the name of God upon every one; "for," said he "it is God himself, who writes it!" I tried to argue him out of this notion; but unfortunately could find no tree without these characters—some high up, and some lower down in the trunk—some large and others small—but still to be found on every tree. I was almost in despair, when we came to a part in the wood where we found one of these trees down in a hollow under the road, and another upon the precipice above. I was ready to stake my credit upon the probability, that no traveller would take the trouble to go up to the tree above, or down to the tree below, merely to write the name of the god upon them: and at once pledged myself to Nathoo, that he should find neither the god's name nor that of his wife. I sent one man up and another down; and they found no letters on the trees; but this did not alter their opinion on the point. "God," said one, "had no doubt put his name on these trees, but they had somehow or other got rubbed off. He would in good time renew them, that men's eyes might be blessed with the sight of his holy name, even in the deepest forest, and on the most leafless trees."* "But," said Nathoo, "he might not have thought it worth while to write his name upon those trees which no travellers go to see!" "Cannot you see," said I, "that these letters have been engraved by man? Are they not all to be found on the trunk within reach of man's hand?" Of course they are," replied he, "because people would not be able conveniently to distinguish them if God were to write them higher up!"

* * * * *

*Every Hindoo is thoroughly convinced that the names of Ram and his consort Seeta are written on this tree by the hand of God; and nine-tenths of the Mussalmans believe the same.

"Happy the man who sees a God employed
In all the good and ill that chequer life,
Resolving all events. with their effects
And manifold results, into the will
And arbitration wise of the Supreme."
—*Cowper.*

That the book enjoyed a fair amount of popularity is shown by the fact that a third edition, edited by Vincent A. Smith, was published by the Oxford University Press so late as 1915; but no one seems to have bothered himself about the identity of the wonderful tree till Lt.-Col. P. R. Butler of Nether Wallop, Hants, sent the following query to the *Field* (August 7, 1943):

I should be grateful to any of your readers who could tell me the botanical name of an Indian forest tree described by Sleeman in his "Rambles and Recollections of an Indian Official" (Vol. I, p. 97) and called by him the "Silver tree" or *Kulpa Briksha.* He mentions its having "a soft silvery bark, and scarcely any leaves" and records that it is considered sacred to the god Ram and his consort Seeta. I can find no reference to it in Firminger."

This attracted the notice of Mr. T. M. Coffey, I.F.S., Chief Conservator of Forests, Bengal, and was circulated with a view to solve the riddle, if possible. Among the names suggested in response were *Adansonia digitata* L. (Bombacaceæ), *Leucadendron argenteum* R. Br. (Proteaceæ), *Saraca indica* L. (Leguminosæ), and *Tournefortia argentea* L. f. (Boraginaceæ); but for reasons to be presently stated we have come to hold a totally different view.

It appears that one of the names by which *Adansonia digitata* is known in Ajmer and Delhi is *Kalp briksh* (a local form of the Sanskrit word *Kalpa vriksha*); but neither *Adansonia* nor *Leucadendron* and *Tournefortia* are in any sense "Indian forest trees." The first two are both of African origin, occurring in India only as *introduced* plants, the former in various localities and the latter in the Nilgiris, while *Tournefortia* grows on the sandy coasts of Ceylon and in the Nicobar islands. The name of *Saraca indica* was suggested by Lt.-Col. Butler's statement that the tree was "considered sacred to the god Ram and his consort Seeta;" but this small tree is not a native of the forests of Central India, where it is only cultivated in gardens. All these trees, which are not also characterised by the possession of a silvery bark, must therefore be ruled out of consideration.

Had Sleeman been as much interested in plants as he appears to have been in the geological structure of the country through which he was passing and referred to the distinguished botanist (Dr. Nathaniel Wallich, F.R.S.), who was then in charge of the East India Company's Garden near Calcutta (afterwards the Royal Botanic Garden, Sibpur), there would have been no occasion now, after the lapse of a century, for speculation regarding the identity of the tree.

It appears that Sleeman was travelling northwards towards Damo across the Vindhyan plateau and that the tree in question was met with somewhere in the Damoh district, which is now included in the Northern Forest Circle of the Central Provinces, about the 25th November, 1835. We have to find out (*i*) what large forest tree with a *soft silvery* bark, which

is deciduous about the month of November and is locally known by the name of *Kullup* or *Kulpa briksha* or by some other similar name, is characteristic of this area ; (*ii*) whether this is the tree referred to ; and (*iii*) on what authority the tree has been styled "The Silver tree" at the head of the chapter.

The only tree which will satisfy the necessary conditions is, as far as we can judge, *Sterculia urens* Roxb., which sheds its leaves in October and remains leafless till June. As observed by Haines in his *Forest Flora of Chota Nagpur* (1910) and *Botany of Behar and Orissa* (Part II, 1921), it is a conspicuous feature of the dry rocky hill country south of the Ganges and its thin, papery bark appears white in the distance ; and this silvery appearance serves at once to distinguish it from other trees with which it is associated. In Brandis's *Forest Flora of North-West and Central India* (1874) and Witt's *Descriptive Botanical List of the Northern and Berar Circles of the Central Provinces* (1916), one of its local names is given as *Kulu*. The names *kullup* and *kulpa briksha* given in Sleeman's book are not mentioned in any of the numerous other works that we have consulted as the vernacular names of any Indian forest tree. These names must therefore be attributed to the ingenuity of some over-zealous attendant like Nathoo ; for had they been in current use, they would not certainly have escaped the notice of forest officers in the course of their professional activities. Taking everything into consideration, we are forced to conclude that the mysterious tree referred to in the anecdote must have been *Sterculia urens*.[2]

The term "Silver tree" is not found in any standard work as the English name of an Indian tree and was evidently coined by Sleeman himself in order to emphasise the colour of the bark. The name properly belongs to *Leucadendron argenteum*, which is so called from its leaves being covered with fine silky hairs and not on account of any peculiarity in its bark.

It will be recalled that Rama and his consort spent a portion of their exile in Dandakaranya, a vast forest tract lying to the south of the Vindhyan range and between the Narbada and the Godavari. We may presume that the names of Rama and Sita had been engraved as an act of piety by bands of devotees travelling on foot southwards in pre-railway days on pilgrimage to this hallowed region and to the reputed site of Rama's *ashrama* or hermitage in the vicinity of Nasik, near the headwaters of the Godavari. The trees seen by Sleeman must have disappeared long ago, but it would be interesting to know whether the practice recorded by him still persists.

Our sincere thanks are due to Mr. I. Banerji, M.SC., of the University College of Science, and Mr. J. C. Saha, M.SC., of the Presidency College, Calcutta, for the great trouble they have taken in providing us with extracts and other information from Sleeman's *Rambles and Recollections*, which was not available at Dacca.

2. A brief reply to Lt.-Col. Butler's query, embodying our conclusions, has been published in the *Field* of the 16th September, 1944.

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LORANTHUS ATTACK IN *SAL* PLANTATIONS.

By D. A. G. Davidson, I.F.S.

(*Divisional Forest Officer, Jalpaiguri, Bengal*)

In 1941 it was realised that the *sal* plantations of the Moraghat Reserve of Jalpaiguri Forest Division, Bengal, were heavily infested with Loranthus and that the eradication of the parasite was very necessary. The trees were strong and apparently healthy although there was a tendency to epicormic branching in some of the older plantations.

The species of Loranthus were identified as *Macrosolen cochinchinensis* (Lour) Van Tiegh. (Syn. *Loranthus ampullaceus Roxb.*) and *Loranthus Scurrula*. Verna ul r names are: Garo, *Panhar*, Urao, *Banda*, Nepali, *aijheru*.

The spread of Loranthus is interesting and I am indebted to Mr. Inglis, Curator of the Darjeeling Natural History Museum, for the following note on the subject:

"The birds which spread the Loranthus are different kinds of flowerpeckers, in the Duars the Indian scarlet-backed flowerpecker (*Dicaeum C. Cruentatum*) and probably the other two flowerpeckers, the plain-coloured flowerpecker (*Dicaeum minullum olivaceum*) and the Sikkim yellow-vented flowerpecker (*Dicaeum chrysorrhaeum intensum*). but the last is less common than the others. The scarlet-backed one is the commonest, their mode of procedure is, I quote Whistler, who writes about another similar species: 'It flies from clump to clump and on the clumps it hops from bunch to bunch of flowers. . . . . Each berry is tested with the mandibles. If ripe it is plucked and swallowed, broad-end first. After finding and bolting down three or four ripe berries one after another the bird retires to the extremity of some bare bough and sits quiet for a few minutes. . . . It is during this interval that the mischief is done; for hardly has the bird bee i there a couple of minutes than you see him becoming uneas and presently one of the seeds is extruded evident'y with some effort. The seed is invariably extruded broad-end first by a final jerky and dipping motion of the posterior part of the body during which the bird often pivots round from its normal crosswise position on the branch to one nearly along it. The extruded seed, which is copiously covered with viscous matter and has a viscid thread-like process at each end promptly adheres to the perch. Digestion is extremely rapid and each seed appears to pass out some three or four minutes after the berry is eaten. Immediately it has got rid of the unnecessary ballast the flowerpecker flies off to another clump. . . and the process starts afresh. In this manner the parasitic seed is conveyed not only to other branches of the same tree but to other trees in the neighbourhood.

There is another flowerpecker, the Indian thick-billed flowerpecker (*Piprisoma a. agile*), found practically all over India but which we have not yet come across though *said* to be common at Mangpu at lower elevations and also recorded to have been got near here at 7,000 feet. It may occur in the Duars. It has a different method. It does not swallow the fruit entire: it separates the fleshy part from the seed, swallows the former and gets rid of the latter by cleaning its bill on a neighbouring twig. Three or four berries are eaten and thus disposed of and got rid of in the neighbourhood of the parasitic plant and are not carried to other trees so that the damage done by this flowerpecker is not as serious as that done by the others. In this bird the beak is swollen and very different to that of the others and is apparently the reason for different feeding habits."

In a letter dated 10-2-42, to the Senior Conservator of Forests, Bengal, the Pre nt, Forest Research Institute, Dehra Dun, w ot as follows:

"I have the honour to sa that in the no e of my tour which has not yet been despatched to you, I have said that this Institute w u

do what it can to help you with the *Loranthus* pest. I fear there is not a great deal of information. There is a paper by Salim Ali called "The Role of Sunbirds and Flower-peckers in the propagation and distribution of *Loranthus longiflorus* in the Konkan," *Jour. Bom. Nat. Hist. Soc.*, Vol. XXXV, pp. 144—149, and also "Flower-Birds and Bird-Flowers in India," *ibid.*, Vol. XXXV, pp. 598—601.

The most important seed-dispersers of *Loranthus* are birds called the flowerpeckers (*Diciaedae*) but occasionally *bulbuls* and the crimson-breasted barbet will swallow the berries. The birds mainly responsible for the fertilisation of *Loranthus* flowers are the various sunbirds. The white-eyed (Zosterops) and *bulbuls* also assist in cross-pollination.

I can suggest nothing reliable about control measures. The fairly obvious thing would be to shoot the birds and encourage their pests but there is no information whether by so doing a more serious balance of nature might not be upset nor is there any information that it would do any good because a fresh influx of birds might start the whole over again.

The real point is that there is no reliable information at all. It is the work of a specialised ornithologist such as Mr. Salim Ali and it means quite a considerable investigation before any real opinion can be given. If Bengal considers that this *Loranthus* pest is sufficiently serious they will no doubt take steps to have such an investigation made and they might like to get in touch with Mr. Salim Ali. His address is 33 Pali Hill, Bandra, Bombay. If this Institute can do anything to help, they will gladly do so but the problem is rather outside anything for which there are facilities here."

In the cold weather of 1941-42 all the Moraghat plantations were thoroughly gone over and each tree found infested was marked with a coal-tar ring. Men were then employed who, using ladders or climbing, cut down the infested branches. That cold weather Loranthus was removed from 29,050 *sal* trees over 793 acres of the Moraghat plantations.

In the cold weather of 1942-43 these operations were again carried out over the same area, a second coal-tar ring being put on trees which had again been attacked and a single ring on those trees which showed Loranthus for the first time. Four thousand and twelve trees were found re-attacked and 5,081 were freshly attacked, a total of 9,093.

In 1943-44 the operations were repeated and it was found that 3,750 trees had been re-infested for the second or third time and 11,213 had been freshly infested, a total of 14,963.

It has not yet been possible to repeat the work this year owing to pressure of work and shortage of labour but casual inspections appear to indicate that infestation is this year on a very reduced scale.

No trees have ever been found to have died as the result of Loranthus attack.

In the Kainjal (*Bischofia javanica*) plantations of 1920 to 1930, an area of 35 acres, in the Dalgaon Reserve of the Moraghat Range 1,095 trees were found in 1941-42 to be Loranthus-attacked. The Loranthus, species unknown, was cut out and no further attack has been noticed up-to-date although *sal* trees alongside have been attacked annually.

The average cost of cutting out the Loranthus was one anna per clump.

The following table gives the results for each cutting series :

Cutting series	Years of plantations	Area in acres	Number of trees fonnd attacked and dealt with 1941-42	Number of trees reinfested 1942-43	Number of trees fully attacked 1942-43	Number of trees reinfested 1943-44	Number of trees freshly attacked, 1943-44
1	2	3	4	5	6	7	8
Northern ..	1922—32	338	17,445	2,792	2,324	2,283	3,967
Central ..	1923—32	127	4,337	395	493	960	1,492
Southern ..	1920—32	328	7,268	825	2,264	507	5,754
TOTAL ..	1920—32	793	29,050	4,012	5,081	3,750	11,213

AFFORESTATION OF *BELAS* IN THE PUNJAB.

By Partap Singh, I.F.S.

The Bela.—Belas are alluvial riverain wastelands scattered along the banks of the rivers in the Punjab (including the Indus) just from where these rivers emerge from the hills right down to the point of their confluence. Though the rainfall in this large tract varies from 30 inches to less than five inches, there are several features, in addition to the very hot and long summer, which are characteristic of all the *belas*.

They are subject to annual or periodic flooding which usually occurs during the rainy months of July and August. The water table is 10 to 15 feet below the surface but rises with the increase of water in the rivers from May to August, making the soil moist, even right up to the surface in some areas.

The low stretches (*kachcha bela*) bordering the river are inundated frequently, are very unstable and consist almost entirely of pure sand. Further back, the land is higher and stable (*pucca bela*) and is characterised by a crust of hard, clayey soil, one to two feet thick, overlying layers of sand similar to those of the *kachcha bela*.

Vegetation.—Following the floods, the fresh alluvium deposits are colonised by pioneer species like *pilchi* (*Tamarix dioica*) and *kahi* (*Saccharum spontaneum*), followed by *kana* (*Saccharum munja*). When through changes in the course of the river, a *kachcha bela* becomes *pucca*, the pioneer species are succeeded by such trees as *kikar* (*Acacia arabica*), *shisham* (*Dalbergia sissoo*), *phulai* (*Acacia modesta*) and in lower reaches of the rivers by *poplar* (*Populus euphratica*). *Kana* and *Kikri* (*Acacia farnesiana*), however, are more gregarious and occupy a much larger area of the *belas* than the tree crops. Most of the *shisham* forests seen on these *belas* are artificially raised rather than natural, and under very moist conditions mulberry is coming in naturally under the *shisham*. In blanks, the commonest grasses are *dab* (*Eragrostis-cynosuroides*), *khabbal* (*Cynodon-dactylon*) and *kahi* (*Saccharum spontaneum*.)

First afforestation.—The *belas* first came into prominence some eighty years ago when they were acquired by Government for raising plantations to meet the fuel requirements of the Railways, and were constituted into reserved and unclassed forests. Some of the better lands were ploughed and sown with *shisham* seed, but as coal completely replaced the use of wood by the railways, the importance of these *belas* to Government was almost completely lost. Forest officers, however, were struck by the possibilities of these plantations and the more enthusiastic of them continued to add small areas.

The first working plan.—The very successful use of ' stumps ' (root and shoot cuttings about one foot long, with 9-10 inches of the former and 3 inches of the latter) for afforestation in irrigated plantations was soon adopted for *belas* also, which made the possibilities look even brighter. Forest officers with experience of *bela* plantations pressed for the recognition of the importance of this work; papers were read at forest conferences, and finally the first working plan for the *belas* was ordered some seven years ago to be prepared for the forest areas on the Chenab and Jhelum rivers, included in the Depot West Forest Division. There are many interesting problems connected with tending and regeneration of *bela* forests, but it is proposed to deal with their afforestation only in this article.

The technique of irrigated plantations applied to belas.—Pending sanction, work under the working plan was started in 1940 and about forty acres planted. So overwhelming had been the success of stump planting in irrigated plantations as compared to direct sowing of *shisham* seed, that not only was the use of stumps for afforestation in *belas* prescribed but almost the entire technique of raising the irrigated plantations was adopted for the *belas*. Trenches, one foot wide and six inches deep were dug ten feet apart over the entire coupe; and with the start of the monsoon, *shisham* stumps were planted 6 feet apart on the berms of trenches. They were watered later during September and October. At the end of the season the picture presented by the areas taken up was nothing but dismal. About half of the total number of stumps planted were dead (despite replacements) and the remaining plants were not taller than 6 or 7 inches; with a considerable proportion that was not likely

to survive long. The nursery (prepared similarly by sowing seed on the berms of trenches) that was to supply stumps the next year proved equally disappointing.

Causes of failure.—A searching enquiry into the causes of this failure revealed that the conditions for the growth of plants in the *belas* were very different from those in the irrigated plantations, particularly with regard to the availability of water, which in the dry plains is by far the most dominant of all the factors of locality. While the supply of water is assured and regular in irrigated plantations, it is far from certain for young plants in the *belas*. The trenches that bring life-giving water to the plants in irrigated plantations, merely serve to drain it away in the *belas*. Furthermore, on low-lying land, the stumps had been drowned by the inundations. Failure to realise these essential differences naturally led to the failure of the plantation.

Development of 'boat-pit' technique.—If success is to be achieved in afforesting these semi-arid areas, the planting must be made independent of the precarious rains and the moisture in the soil increased and conserved, so that the plants may be established within a few months to be able to withstand the post-monsoon drought. All this was achieved by planting stumps at the bottom of elongated shallow pits in spring and watering them till the rains break. The results obtained were far beyond the expectations of even the greatest optimist and most people found it difficult to believe that the "belas" had produced man-high plants in the course of a single growing season. The detail of this technique, which derives its name from the resemblance of the pit to the boat, (see diagram), which has given consistently good results and is used to afforest hundreds of acres annually is given below:

DIAGRAMS ILLUSTRATING 'BOAT PIT' TECHNIQUE.

FIG: 1.

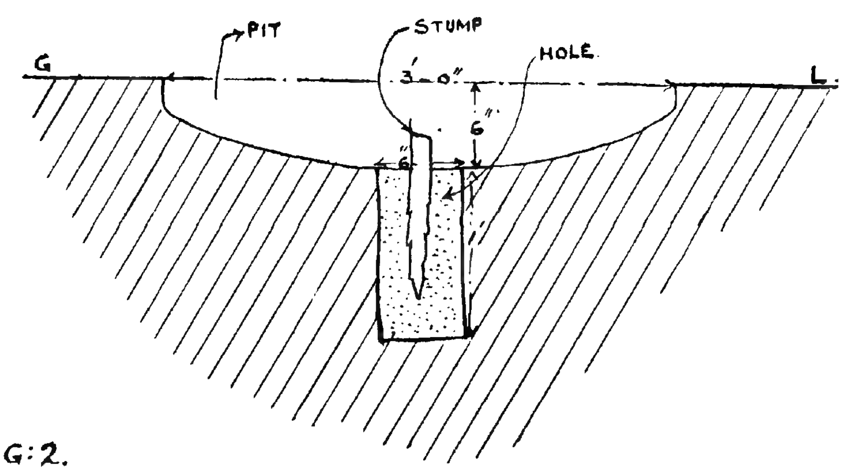
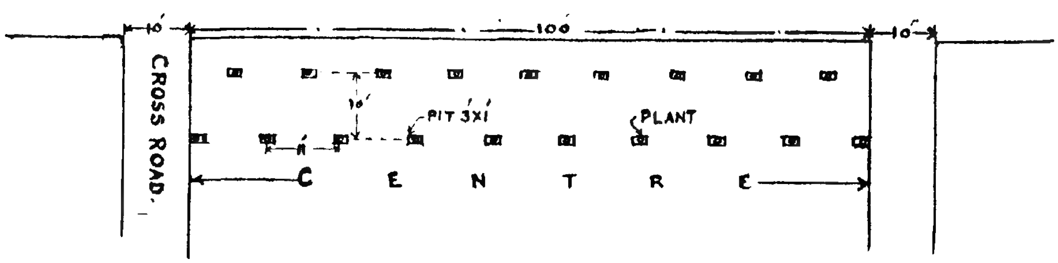


FIG: 2.



Clearing of land.—The first thing to do is to clear the land. This includes both *kana* stubbing and debris burning. After the year's coupe has been marked on the ground as prescribed, any trees standing in it are listed, sold and removed. The debris is then burnt

along with the *kana*, which often exists in dense almost impenetrable masses. Unless the *kana* is sparce it is impossible to stub it out effectively without burning. Besides, burning makes the stubbing very much cheaper. *Kana* is burnt under control in winter on a calm day.

Layout.—When the coupe has been cleared, it is marked out on the ground into strips 100 ft. wide, called 'centres' alternating with 'cross-roads', 10 ft. wide both of which run right through the length (or the breadth) of the coupe. Across the width of the 'centres' shallow elongated pits (3 ft. long, 1 ft. wide and about 6 inches deep, shallower towards the ends than in the middle) are dug 3 ft. apart (end to end) in lines 10 ft. apart (other spacings are discussed later). A hole, 6 to 8 inches in diameter and about 1 ft. deep is then made in the bottom and middle of each pit, in which the stump is actually planted, when the season begins.

It will be observed about the pit that its elongation helps to collect surface rain water, so useful when the shower is light; its slope enables almost the entire collection of water to be utilised by the plant, its sunken plant bed conserves the supplies and its shallowness prevents the young plants from getting drowned for long. The hole enables the stump to be conveniently placed at the exact level required and the earth to be packed firmly round the stump.

Wells.—It has been found that the maximum distance to which a coolie can carry water to the plants economically is about 100 ft. and therefore one well is dug to every acre of land to be afforested. Wells are easy to dig but as the subsoil is almost all sand and the wells are liable to collapse, a wooden framework 3 ft. square and 4 ft. long is nearly always sunk to reinforce the walls.

Fencing.—Young *shisham* plants are readily browsed by cattle, so a fence has to be put round the coupe. Two strands of barbed wire have been found quite effective though in peace-time three strands were preferred. Plants are safe against cattle damage after 5 years.

Planting.—Planting is started exactly on the first of March and finished by the middle or the third week of that month. The great advantage of starting on a fixed date (not that a variation of a few days either way would make any material difference to the growth of plants) is that the supply of stumps which often have to be obtained from outside, can be arranged to a time table, so that neither the labourer nor the stumps have to wait one for the other. In planting, the hole is partly filled with earth first and the stump so placed in it, that only the shoot remains above the ground when the hole is completely filled up. Soon after, the plant receives its first watering. Depending of course on weather, the sprouting takes place in about 7 to 10 days, though in a few cases it might be delayed by as much as a month.

Spring planting has generally proved much more successful than monsoon planting but for low-lying areas it is invaluable and essential. After high floods the water remains standing for days over large areas in which spring plants alone with their shoots well above the surface of water, can survive. The young monsoon plants get drowned, buried and killed.

Hand Watering.—Watering of the plant is the most important, laborious and expensive of all the works, and has therefore to be watched and controlled properly. Neglect at any time during the first season may result in drying up of plants on which considerable time, energy and money has already been spent. Experiments have shown that watering is best done weekly, though this must somewhat be adjusted with weather and soil conditions. In actual practice, only six days out of a week are devoted to regular watering and the seventh to such miscellaneous things as repairing wells, clearing rat-earth from above the plants, replacing failures and giving extra water to poor-looking plants. One pitcher or half a kerosene tin of water is given to every plant and a coolie can water about 150 plants daily. Ordinarily the watering stops when the monsoon breaks but if the rains are poor the watering has to continue on high and dry areas right up to the end of the season. Plants have been seen dying in their second and even the third year but such casualties are so rare that no special notice need be taken of them.

Weeding.—With the protection afforded by fencing, the grasses and weeds that had been kept down by grazing, grow tall and thick almost to the point of choking the young *shisham* plants which fail to grow and even die if not weeded. One to two weedings during first rains are enough and it is seldom that a weeding is really required in the second season.

Cost of Afforestation.—Due to the extraordinary rise in wages of labour, the cost of afforestation has gone up tremendously, as will be seen from the latest figure given below,

but in peacetime this could be done for a third of the amount:

No.	Nature of work		Cost per acre. Rs.
1.	Stubbing out *kana*, etc.	..	13
2.	Digging pits and holes	..	9
3.	Planting	..	3
4.	Digging wells	..	12
5.	Watering	..	48
6.	Stumps	..	1
7.	Weeding	..	4
	Total	..	90

These costs are based on 10 ft. by 6 ft. planting.

Spacing Experiments.—A glance at the figures in the last paragraph shows that if any reduction is at all possible in the cost, the item for watering should prove most fruitful. Now the cost of watering is directly proportionate to the number of plants put in per acre and there seems no reason why it should not be possible to reduce this number. Accordingly, triangular planting has also been introduced during the last three years to give the following espacements:

1. Plants 9 ft. apart in lines 8 ft. apart.
2. Plants 10 ft. apart in lines 9 ft. apart.
3. Plants 11 ft. apart in lines 10 ft. apart.

It will be seen that as compared to 10 ft. by 6 ft., a spacing of 11 ft. by 10 ft. reduces the number of plants required per acre to just one half. Whether this or any of the other experimental spacings mentioned above is finally adopted still remains to be seen.

General.—If the war has made afforestation very expensive, it has also opened up new avenues for development of other methods. Lands which were previously sub-marginal to agriculture have now become arable on account of the "grow-more-food-and-fodder compaign." Taking advantag of this opportunity real *taungya* methods are now being experimented with and have given very hopeful results so far.

These *bela* lands can grow very fine *shisham* and it is proposed to manage the forests on a sufficiently long rotation to produce timber.

SIXTH SILVICULTURAL CONFERENCE

(Dehra Dun -April 2nd to 4th, 1945)

By A. L. Griffith, D. Sc.,

Secretary of the Conference.

The sixth silvicultural conference has just concluded. It was a short conference to endeavour to ascertain the effects of the war on silviculture and forestry in general and what research is needed urgently in connection with problems arising out of the war and for post-war plans. It also aimed to re-establish the personal contacts that had been unavoidably lost in war conditions.

The next conference is to be held in October, November, 1946 and is to be a full conference to which it is hoped to invite delegates from the Indian States and neighbouring countries such as Burma and Ceylon. (War-time difficulties of food, accommodation, and travel forced us to limit this last conference to one delegate per province).

Eighteen months is a very short time in which to get the resolutions of our conference into effect and another conference going. In consequence, in order to get the resolutions of the sixth conference widely known as quickly as possible it has been decided to publish them in the *Indian Forester.*

It must, however, be emphasised that at present these are only the resolutions of the conference and have not yet been commented on or accepted by any higher authority.

RESOLUTIONS OF THE SIXTH SILVICULTURE CONFERENCE HELD AT DEHRA DUN FROM APRIL 2ND TO 4TH, 1945.

ITEM 1.—POST WAR SILVICULTURAL RESEARCH

Whereas

(1) Owing to war conditions, silvicultural research has largely been held in abeyance (on a " care and maintenance " basis) and research staff employed on urgent war works.

(2) It is desirable that immediately after the war, silvicultural research should be re-established to deal urgently with problems directly resulting from the war and also connected with post-war development.

(3) The resumption of silvicultural research is dependant upon the immediate provision of adequate and suitable staff.

This conference resolves that—

(1) *The resolution on items 1 and 2 of the Quinquennial conference of 1939 be re-affirmed, and considers that the pre-war organisation of silvicultural research should be continued in the post-war period, modifying it and extending it in accordance with post-war necessities, special attention being paid to the importance of providing adequate staff.*

(2) *It be recommended to the Senior Officers' Conference that all provinces should have silviculturists and adequate staff.*

(3) *The attention of the Senior Officers' Conference be invited to the fact that most provinces and the Forest Research Institute have great difficulty in attracting the most suitable men for silvicultural research posts as in general the extra pay and allowances if given at all are inadequate to compensate for the arduous nature of work and living conditions as compared with those of the normal district staff.*

ITEM 2.—THE EFFECT OF WAR ON SILVICULTURAL AND YIELD PRESCRIPTIONS OF WORKING PLANS

Whereas

In most provinces silvicultural prescriptions have necessarily been neglected during the war owing to the priority given to supply work.

This conference resolves that—

Detailed schemes to bring such prescriptions up-to-date are necessary in the provinces affected and the provision of the necessary finance and staff to implement them is essential.

Whereas

In most provinces the yield prescription of working plans have been departed from in many ways during the war owing to the heavy and continued demand for timber and fuel.

This conference resolves that—

(1) *Every province affected should set up an efficient organisation to overhaul and rewrite all*

working plans as quickly as possible and that provinces should be asked to devote adequate funds for the preparation of the new working plans and for carrying them out even though these will necessitate heavy expenditure on increased cadres of officers and subordinate staff.

(2) *These problems should be dealt with by a separate working plans circle.*

WHEREAS

The demand for timber, firewood and minor forest products is continually rising it is essential that the future requirements of the consumers be known.

THIS CONFERENCE RESOLVES THAT—

The Senior Officers' Conference should be invited strongly to recommend that each province and state should start immediately to make a survey of quantities of timber, firewood and minor forest products likely to be required in the province or state within the next 25 to 30 years. This survey should also estimate what can be produced within the province and state and in the adjoining territories.

In the collection of this information and in the coordination of results obtained from it suitable public bodies such as the Utilisation Board, Chambers of Commerce, as well as industrial and agricultural interests should be consulted.

WHEREAS

War problems have necessitated immediate research into many forest problems,

THIS CONFERENCE RESOLVES THAT—

Joint investigations and tours to study the following subjects should be started as soon as possible :—

(*a*) *Regeneration of fir forests.*
(Punjab, U.P., N.W.F.P., Kashmir, Tehri-Garhwal).

(*b*) *Efficiency of enumerations.*
(U.P., N.W.F.P., Punjab etc. etc.)

(*c*) *Control and fixation of sand drift.*
(Sind, Punjab, Madras and many states)

(*d*) *Species suitable for the afforestation of arid and desert regions including the varieties of Prosopis juliflora.* (General problem).

(*e*) *Regeneration of salai* (*Boswellia serrata*) *forests.*
(C.P., and Central Indian States).

(*f*) *De novo regeneration of sal* (*Shorea robusta*)
(U.P., Assam, Bengal).

(*g*) *Casuarina plantation technique.*
(Madras, Bombay, Orissa).

(*h*) *Quick growing broadleaved tr s of industrial value* (Punjab).

(*i*) *Timber species suitable for dry areas both with and without irrigation.*
(Sind, Punjab and N.W.F.P.).

ITEM 3.—COOPERATIVE SEED COLLECTION AND DISTRIBUTION.

WHEREAS

(1) The existing system of co-operative seed collection and distribution is unlikely to be adequate to meet the large demands for seed we anticipate in the immediate post-war period.

THIS CONFERENCE RESOLVES THAT—

(1) *Provinces and States should make their own seed arrangements if possible and only in cases of difficulty should refer their indents to the central silviculturist.*

(2) *Each province should have one authority (such as the provincial silviculturist) to deal with indents and that States should be asked to appoint similar authorities.*

(3) *Provinces and States when possible should prepare lists for expected seed crops and seed crop surpluses, for species likely to be in demand.*

(4) *Trained seed collectors should be employed by the provincial seed authorities for the collection of seed and preparation of forecasts, etc.*

(5) *In seed collection due regard should be paid to seed origin, race and form of trees, freedom from insect and fungal pests, etc.*

(6) *It be recommended to the Senior Officers' Conference that the price of seed charged to other provinces should not exceed the cost of collection plus 25%.*

(7) *Importing provinces should establish seed testing stations when necessary.*

(8) *The attention of the Senior Officers' Conference should be invited to the danger of spreading local pests round the country and of importing new pests from abroad.*

(9) *The importance of teaching correct methods of seed collection in forest schools be*

brought to the notice of the Senior Officers' Conference.

(10) *In order to collect information on seed pests provinces and States should be asked to send small samples of all infected seed to the F. R. I. together with a note on whether or not they consider the infection economically important.*

ITEM 4.—THE EFFICIENCY OF ENUMERATIONS.

WHEREAS

(1) The general overfelling of the forests of India and in particular the felling of special sizes of selected species for war purposes has rendered it imperative that as soon as the war is over large scale enumerations be done in a number of provinces for working plan purposes in order to estimate war damage and remaining resources.

(2) Enumerations will also be necessary to provide for post war planning.

(3) The accuracy of enumerations is a matter of permanent importance.

(4) At present we have little or no information of the potential accuracy of current methods of enumeration.

(5) It appears probable that much useful information can be obtained fairly quickly by examination of existing data.

THIS CONFERENCE RESOLVES THAT—

(1) *The central silviculturist be authorised to proceed at once with the examination of existing data to endeavour to give an indication as soon as possible of the probable accuracy of different methods and intensities of enumerations in different types of forest and terrain.*

(2) *Approximate information is needed quickly rather than a more detailed accurate complete research.*

(3) *The staff used for enumeration work should be of the highest quality available, and should rèceive extra remuneration.*

(4) *After the examination of this data a paper or leaflet should be written on the necessity for determining the precision of sampling enumerations.*

ITEM 5.—NATURAL AND ARTIFICIAL REGENERATION OF TEAK.

WHEREAS

(1) Although in dry teak forests there is usually no difficulty in obtaining natural regeneration from advance growth and coppice shoots, far greater difficulties are experienced in the moister types owing to uncertain germination, heavy seedling casualties, tending problems etc. These difficulties require further investigation and research.

(2) Different methods of artificially regenerating teak are practised in various provinces even under similar climatic conditions leading to the conclusion that wider experience would tend to the improvement in some, if not all, cases of provincial technique.

(3) The majority of provinces favour the undertaking of a combined joint tour of inspection of teak growing areas.

THIS CONFERENCE RESOLVES THAT—

A joint cooperative tour be undertaken as soon as conditions permit in order to study artificial and natural regeneration of teak, defoliation control, and management problems, especially those arising from the war, the whole subject to be written up at the end of the tour.

ITEM 6.—THE AFFORESTATION OF DRY AREAS.

WHEREAS

(1) Zones of low rainfall cover two-fifths of India.

(2) Much of the land in these dry zones is unproductive or only partially productive, and there are shortages throughout of fuel, fodder, and pasture.

(3) In the desert areas there is considerable sand movement which as in many other countries may damage more valuable lands if not arrested.

(4) Vegetative cover is possible where the annual rainfall is as small as 6".

(5) Owing to increasing population the demand for small building timber, fuel for domestic heating and fodder and grazing for animals is continually rising and hence the satisfaction of these demands should be primary objects of management in such dry areas.

THIS CONFERENCE RESOLVES THAT—

(1) *The attention of the senior officers' conference be invited to the importance and urgency of the afforestation of these dry areas—particularly the fixation of the desert—and the necessity for adequate action in the near future.*

(2) *Amongst the essentials that should have attention are (a) recruitment and training of the staff required to carry out operations. This*

staff will have to work in trying conditions and they must be well paid and properly housed.

(*b*) *Provision of necessary funds. These will be large and should form part of post-war reconstruction finance.*

(*c*) *Propaganda on a large scale to endeavour to obtain the co-operation of the local population.*

(*d*) *Legislation to give the necessary powers to enable the work to be carried out.*

WHEREAS

All government lands are not already fully utilised.

THIS CONFERENCE RESOLVES THAT—

The attention of the senior officers' conference be invited to the desirability of recommending that canal, railway and roadside areas should be afforested and managed under working plans prepared by the forest department.

WHEREAS

Our present technical knowledge of dry areas is inadequate,

THIS CONFERENCE RESOLVES THAT—

Research be carried out in connection with—

(*a*) *afforestation technique in the two rainfall belts* 0 to 10″ *and* 11″ *to* 20″,

(*b*) *irrigated plantation technique,*

(*c*) *contour trenching to ascertain the best methods,*

(*d*) *mechanical means of soil and sub soil working,*

(*e*) *the relative merits and costs of live hedges and fencing particularly in connection with grazing areas. Attention is drawn to the experience with live fences and hedges already gained in Madras,*

(*f*) *the propagation of suitable species and varieties of species including exotics.*

WHEREAS

The work so far done has shown that it will not be easy and difficulties such as drought, white ants, frost, hares, grazing by animals including camels and goats, fungal and bacterial diseases, locusts, etc., are likely to occur.

THIS CONFERENCE RESOLVES THAT—

Experience gained should be carefully recorded and that every effort be made to surmount the difficulties experienced.

Finally

THIS CONFERENCE RESOLVES THAT—

The list of trees, shrubs and grasses that grow in low rainfall areas compiled for this conference should be published.

ITEM 7.—THE REVISION OF THE SILVICULTURAL RESEARCH MANUALS

WHEREAS

(1) The fifth silvicultural conference emphasised the need for the early revision of the manuals and decided the general lines on which this should be done.

(2) The need for the revision of the manuals is even more urgent now than it was at the time of the last conference.

(3) The central silviculturist in his efforts at their revision has found it impossible to include all the required information on statistical methods in the experimental manual.

THIS CONFERENCE RESOLVES THAT—

(1) *The central silviculturist be authorised to compile the "Silviculture Research Code" in three volumes to be called*

Vol. I.—The experimental manual.

Vol. II.—The statistical manual.

Vol. III.—The yield, volume and stand table manual.

(2) *Attention be again called to the importance and the urgency of the revision of these manuals.*

ITEM 8.—GRAZING AND PASTURE RESEARCH

WHEREAS

Grazing and its regulation are major problems in many parts of India.

THIS CONFERENCE RESOLVES THAT—

The resolution on item 11 *of the* 1939 *conference be re-affirmed and at the same time stresses the importance of investigations concerned with direct utilisation and improvement of pasture through regulated grazing.*

ITEM 9.—OUT OF PRINT PUBLICATIONS

WHEREAS

The question has arisen of reprinting and/or revising certain silvicultural publications,

THIS CONFERENCE RESOLVES THAT -

(1) *I. F. R. silviculture Vol. 5 No. 2 Teak plantation Technique be reprinted as soon as practicable.*

(2) *Fodder Trees in India be reprinted.*

(3) *I. F. R. silviculture Vol. I No. 1. A preliminary survey of the forest types of India and Burma be revised and republished as soon as practicable.*

(4) *Items 1 and 2 be given priority owing to their immediate post-war value.*

DATE OF NEXT CONFERENCE

RESOLVED THAT—

The next silvicultural conference be held in Dehra Dun in late October or early November, 1946. *This will be a full conference to which delegates will be invited from the Indian States and neighbouring countries such as Burma, Ceylon, etc.*

PROSOPIS JULIFLORA IN GWALIOR FORESTS

By Om Prakash Bhargava, A.I.F.C.

(*Working Plan Officer, Gwalior*)

1. The problem of reforestation and regeneration of dry fuel areas in Central India and Rajputana is a tough one and requires careful study of several factors such as over-grazing, browsing, soil, and rainfall etc. for its solution. Amongst the Central India and Rajputana States, Gwalior occupies the largest area and the neighbouring states have been looking forward to it for lead in respect of forest management. Factors connected with the general failure of regeneration in these forests have rather a complicated nature and require a separate article to do full justice with them. It is aimed to deal with only one species at present which can be most economically and successfully introduced in afforestation and reafforestation projects and to mention the results of past experiments connected with it. This species is *Prosopis juliflora*.

It was in the year 1924 that the present conservator of forests, Gwalior, Kunwar Parmal Singh, was given a pound of seed of *Prosopis juliflora* by Sir G. T. Birdwood for experiment. He is reported to have obtained this seed from Australia. It was promptly sown in the range compound of Ghatigaon, Gird district, Gwalior, and out of approximately 10 young plants two trees of about 18 feet height and $1\frac{1}{2}$ feet girth still exist. No measures to introduce it in the forests were taken till 1927 when Mr. K. G. Rahalkar, the then officer in charge of ravine reclamation works at Barai Bhind district near the Chambal river, laid out experimental plots with the object of studying its growth in the ravines. Seed was obtained from the silviculturist, Lahore. Sample weighments of the seed were done and the seed weight recorded was 2,130 seeds per lb. It was sown in lines five feet apart on 17-7-27. No observations regarding the germination percentage or period of germination are on record. These plots are still being maintained though no annual measurement data are available. A general study and the relevant data existing in the files gives the following conclusions:

(*a*) The species is very hardy. (*b*) Its moisture requirements are low and as such it can be successfully grown in the area where water table is even lower than 80 feet and rainfall is little below 18 inches. (*c*) It is a strong light demander and can well be raised as pure crop. (*d*) It is not liked by cattle and wild animals and as such is to some extent immune from grazing and browsing damage. Measurements recorded in February 1945 show that the crop has an average height of 21 feet and a girth of $7\frac{1}{2}$ inches. Two thinnings, one in 1940 and the other in 1943, were carried out in each of which about 33 per cent. of the stems were removed. The present number of stems is 262 per acre. The gaps created during thinnings have now covered up and it appears that next year the present number will again have to be reduced.

Gwalior state has eleven districts out of which eight contain forests, having a total reserved forest area of approximately 3,100 square miles. Annual rainfall varies from 10 inches to 65 inches in various districts and similarly the temperature shows wide variations. The distribution of forest species therefore also

exhibits diversion but compulsorily contains some percentage of thorny species. The forests of districts with a rainfall below 30 inches and with maximum summer temperatures of 112° to 116°F contain thorny species like *Acacia catechu*, *Acacia leucophloea*, *Zizyphus xylopyrus* *Zizyphus oenoplia*, *Balanites roxburghii* with varying admixture of other species like *Anogeissus latifolia*, and *Anogeissus pendula* etc. The entire forest area with the exception of felled coupes for three years is open to unrestricted grazing. The grazing fees prevalent in the state are too low while cows and agricultural bullocks etc. are totally exempted from it. The net result of uncontrolled overgrazing is that there is no trace of natural regeneration in the forests and after fellings are over the future crop entirely depends on coppice shoots 50 per cent. of which invariably are either trodden down and damaged by cattle or are browsed. The summed up effect of all this has been that the forests are getting thinner and thinner day by day and the day may not be far off when the dense unexploited forests of 50 years ago will have dwindled out completely.

The main problem before forest officers of the state to-day is the regeneration and afforestation of these dry fuel forests and (under the conditions prevailing) introduction of such species as can stand drought and are to some extent immune from browsing damage. It may be pointed out that the State forests are governed by very strict *shikar* rules and the number of wild animals is immense and consequently the damage by wild game is a prominent feature in dealing with the regeneration problem. Patch plantations tried without fencing have met with complete failure. The sporadic sowings of *Prosopis juliflora* during the last two years have given encouraging results and now systematic experiments are being undertaken by the writer to find the best variety and source of seed of *Prosopis juliflora* suited to our locality. So far the seeds of this species have been obtained from the conservator of forests, Jodhpur, the silviculturist, Punjab and the chief engineer, P. W. D., New Delhi. Recently some seed from the agricultural department, Agra, United Provinces, has been received which will be tried during the coming rains. Germination tests carried out in the nursery beds at Susera have given the following results:

Species:	Origin of seed.	Germination percentage.	Period of germination in days.
P. juliflora	Jodhpur	24%	20 to 36 days.
"	New Delhi	26%	18 to 30 days.

N.B.—1. These are the averages of 10 beds.
2. The pulp of the seed was removed by washing the seed with cold water.
3. Seed was insect attacked but its soundness percentage was not tested, nor was any sorting done.

It was observed that after storing the seed for over three months it was seriously insect attacked, but the germination percentage of the fresh unattacked seed and the insect attacked seed did not show great variation. Even after storage for a period of $1\frac{1}{2}$ years I have obtained almost the same germination percentage. In the forest areas where the watertable is quite low and the rainfall about 15 inches the germination periods have been lower than at Susera a place about 9 miles off from Gwalior where the watertable is not so deep and the rainfall is about 30 inches. As investigations on this point have not been systematic the fact that germination is affected by climatic factors cannot be generalised but there seems to be the possibility that the seed does react to differences in climate.

As regards the best practical method of artificially introducing the species in the forest direct sowing of seed is supposed to be most economic. Transplanting has given poor results. Out of 100 plants only 20 survived during the last season at Susera. Another method has been tried with great success which consists of sowing the seed in nursery beds in July or August. After about ten months in early May when the plants have an average girth of $\frac{1}{2}$ inch to $\frac{3}{4}$ inch at the collar region they are dug out and stumps are prepared. All branchlets from the main taproot are pruned off with a sharp knife. The prepared stump (root-shoot cutting) is 7 inches to 8 inches in length with 6 inches to 7 inches of root portion below the collar region and 1 inch of shoot above it. The stump is placed in a circular grass basket, with moist sandy loam around it. The basket full of wet soil is 1 to $1\frac{1}{2}$ feet long and 2 inches in diameter. The stump is so placed in the basket that about 1 inch portion above the collar region projects out while the

root portion is within the compacted soil. The baskets are placed at some cool spot where they can be conveniently watered. By July the plants are about one foot high and can then be placed conveniently in the pits. Gander grass (*Vitiverea zizanoides*) and *kans* which occurs in abundance in our locality are being used for the baskets. It has been observed that while plants from direct sowings are one foot high at the end of one season stump plants attain a height of $1\frac{1}{2}$ feet to 2 feet. This is a sure method which does not leave any chance of failure in the field and has been successfully carried on for the last two years.

Experiments with regard to the method of sowing and pre-sowing treatment of *Prosopis juliflora* will be carried out this season and the result for the benefit of forest officers dealing with the same problem conveyed to them through the columns of the *Indian Forester*.

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THE EFFECT OF A SOIL STABILISER ON PLANT GROWTH

By A. L. Griffith, D.Sc.

(Central Silviculturist, Forest Research Institute)

Introduction.—Soil stabilisers have been used a great deal in India in recent years to surface mud runways of aerodromes when concrete or tarmac was not available. These stabilisers had some curious effects on small plants and dormant seeds which apparently were in the mud surface when it was stabilised. Many enquiries were received asking for advice on how to get rid of the abnormal plant growth that had occurred. The majority of these enquiries came from the dry and semi-desert areas.

As so much work is being done at present in these dry areas it was decided to try a small preliminary experiment on the effect of a soil stabiliser on plant growth. This was done recently in the demonstration area of the central silviculturist at Dehra Dun. The experiment was done in conjunction with the biochemist who supplied the stabiliser and generally advised on the quantities and method etc. to be used.

Stock for the experiment.—20 flower pots each containing 10 lbs. of soil were sown with 12 seeds per pot of peas (*Pisum sativum*). A few weeks after germination the seedlings were thinned to 4 per pot. When the plants averaged 2½ inches high the pots were divided into 3 lots of 6 at random.

Preparation of the stabiliser solution.—Stabiliser supplied by the chemist at the rate of 1 per cent. of the soil in the pots was added to 4 gallons of water stirring well and allowed to stand for 18 hours. (The actual quantities were 1.8 lbs. of stabiliser in 4 gallons of water). It was then again well stirred and applied to the pots.

Work done.—After preparation of the solution a measured quantity of it was poured on to the soil surface of one set of pots while the other two sets were given equal quantities of ordinary water. After 36 hours a similar quantity of solution was added to the 1st set of pots and one of the previously watered sets while the third set again received an ordinary watering with a similar quantity of water. As soon as this was done the soil in each pot was pressed hard with the hands to make it as compact as possible.

All the pots were then put on a concrete floor and the plants allowed to die of drought, no more watering being done. This was to simulate desert conditions where a very long period of drought usually follows a heavy shower of rain.

The plants were measured for height growth periodically and their condition noted daily.

Results

(1) The stabiliser apparently had no significant effect on the height growth of the plants.
(2) The plants treated with two doses of stabiliser lived for 5 weeks after the application whereas those that had no treatment or only one dose of stabiliser only lived for 4 weeks.

Discussion.—In carrying out the experiment it was noticeable that the surface of the soil in the pots which had had one dose of stabiliser dried and cracked fairly rapidly while with those which had had two doses although the surface did dry and crack it took a much longer time to do so. It is thought that a third application of the stabiliser even though just poured on with a watering can and the surface not compacted would produce a sufficient surface layer for our purpose.

Indications.—The stabiliser is available in quantity and is cheap and it prolonged the life of the plants by one-fifth. This was presumably by reducing surface evaporation although of course evaporation must have been going on through the sides and bottoms of the pots. It is therefore a possibility that this work could be developed to help us in our very dry district work and it *might* enable plants to last over their critical first hot weather.

It is however emphasised that at present it is merely a remote possibility which *might* become an important factor particularly in the case of single trees such as roadside trees.

Further work is in progress.

DEVELOPMENT OF FORESTS AND WOODLANDS IN SIND—I.

BY J. PETTY, M.C., O.B.E., I.F.S.

(*Conservator of Forests*)

Foreword.—The note on "Forests and Woodlands in Sind" was written as a popular article for the information of the general public in Sind, some of whom know little of forestry. It is reprinted in the *Indian Forester* in the hope that it may be read with interest by subscribers.—*Ed.*

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LIST OF TREES, SHRUBS, ETC., MENTIONED

1.	*Arjan*	.. *Terminalia arjuna.*
2.	*Babul*	.. *Acacia arabica.*
3.	*Bahan*	.. *Populus euphratica.*
4.	*Gidamri*	.. *Tamarindus indica.*
5.	*Gulgul*	.. *Bal samodendron mukul.*
6.	*Jaman*	.. *Eugenia jambolana.*
7.	*Kandi*	.. *Prosopis specigera.*
8.	*Kumbhat*	.. *Acacia senegal.*
9.	*Lai*	.. *Tamarix spp.*
10.	*Lohrio*	.. *Tecoma undulata.*
11.	*Mesquite*	.. *Prosopis juliflora.*
12.	Mulberry	.. *Morus alba.*
13.	*Nim*	.. *Azadirachta indica.*
14.	*Pakar*	.. *Ficua infectoria.*
15.	*Rain*	.. *Pithecolobium saman.*
16.	*Siris*	.. *Albizzia lebbek.*
17.	*Tali*	.. *Dalbergia sissoo.*
18.	Olive	.. *Olea ferruginea.*

LIST OF LOCAL WORDS USED

1.	*Abkalani*	.. River floods.
2.	*Dhandh*	.. Water left after floods, a marsh, a miniature lake.
3.	*Nullah*	.. Mountain stream flowing during rains.
4.	*Zamindar*	.. A land holder.
5.	*Jagirdar*	.. A land holder with special rights.
6.	*Huri*	.. A *zamindari* plantation.
7.	*Kacha*	.. Temporary.
8.	*Paka*	.. Permanent.
9.	*Taluka*	.. Subdivision of a revenue district.
10.	*Mukhtiarkar*	Revenue officer in charge of a *taluka*.
11.	*Mahal*	.. Subdivision of a revenue district somewhat smaller than a *taluka.*
12.	*Mahalkari*	.. Revenue officer in charge of a *mahal.*
13.	*Hur*	.. A fanatic follower of Pir Pagaro.

14.	*Maldar*	.. Grazier.
15.	*Kasi*	.. Small irrigation channel.
16.	*Hari*	.. Cultivator.
17.	*Tapedar*	.. Minor revenue official.

[*When cubic ft. figures are given they are for "stacked" c.ft. of which* 1,000 (*a stack*) *average* 250 *mds. in weight and will yield about* 80 *mds. of charcoal.*]

PART I

THE PAST

(*a*) *Pre-War*

1. The Indus Valley has always been well wooded because the chief indigenous trees (*babul*, *kandi* and *lye*) yield seed profusely which readily germinates and, in consequence, any land that receives regular canal, river or flood irrigation is soon covered with jungle unless man interferes. But the higher lying areas which receive no irrigation other than rainfall (average 4″—7″ annually) are only scantily covered with vegetation.

2. On the hills in the west of Sind (where the rainfall averages about 7 inches annually and there is no artificial irrigation) only a sparse ground covering is found of hardy annual grasses and plants together with a few scattered shrubs and trees. Between the hills, however, there is much more vegetation and some of the *nullah* beds and banks are well wooded with stunted but healthy trees. The commonest tree is *kumbhat* which appears to be reproducing itself naturally. *Kandi*, *lohvio*, olive and other trees are also found but no seedlings of these species. The most important of the smaller trees or shrubs is *gugul*, which yields the Gum Mukul of commerce, but there are other valuable medicinal plants.

3. The so-called desert area in the east of the province (rainfall average 7″—15″) has a thicker ground covering of grasses, shrubs and trees than the label "desert" would indicate. The amount of vegetation gradually increases towards the borders of Sind, Rajputana and Cutch where the rainfall is greatest. Most of the trees and shrubs are similar to those growing in the hills.

4. No efforts have been made in the past to improve and increase the fodder supplies, etc., or to counter erosion in either the hills or the desert though together these cover 30,000 sq. miles which is about two-third of the area of the whole province.

5. The *zamindars* in Sind have always been encouraged to raise plantations of trees (*huris*) by assessment concessions and in some areas—particularly around Hyderabad—*huris* are part of the regular farming system. *Babul* is sown on poor or "tired" land and closely grown for 8-10 years. When felled it yields about 2,000 c.ft. an acre which pre-war fetched about Rs. 100. During the rotation the *huri* is supplying fuel, hutting material and leaf fodder for animals and all the time the trees are improving the soil. From the newly-cleared land yields of 25—30 mds. an acre of cotton are obtained for 2-3 seasons.

6. In former times the canal banks, sides of roads and tracks, open spaces in towns, villages, compounds of rest-houses and Government buildings, camping sites, etc. etc., were regularly planted and watered (it has been stated that such was the enthusiasm at one period, the ability of a *mukhtiarkar* was judged by the number of trees he had had planted). Unfortunately interest in this admirable work gradually ceased. The roadside trees were first neglected and then haphazardly felled and—since the local boards took over many roads—have now almost completely disappeared. Village (and in many cases municipal) trees are normally hacked and lopped to such an extent that they give no shade and have no aesthetic value whilst the P. W. D. canal bank planting was completely stopped a few years ago as a measure of economy (a very false economy) and staff for maintenance has been so curtailed that these valuable trees, lacking protection and silvicultural treatment, are deteriorating.

7. Before the opening of the Lloyd Barrage at Sukkur in 1932, however, the rural areas were well wooded and, there were, ample supplies of fuel and the small timber required for hutting and agricultural implements. The woodlands were well distributed throughout the province and, in consequence, wood was obtainable free or very cheaply and was readily accessible.

When the barrage began to function more and more land was cleared of scrub jungle and tree growth began to disappear over large tracts.

8. The reserved forests cover approximately 1,100 square miles which is just over 2 per cent. of the provincial area of 48,000 square miles. Two-thirds of Sind are,

however, so-called desert or hills and the percentage of forests to the cultivated or potentially cultivable area is 6 per cent. In the other provinces in India the average forest total area is 14 per cent.

In the eighteen-nineties it was proposed to earmark a further 200 square miles in the east of the Province to be converted eventually into reserved forest but unfortunately this work was never completed.

9. Until the outbreak of war, however, in spite of the smallness of the forest estate, Sind was a surplus wood fuel area but produced little good quality timber, most of which, required for public works, better class housing, etc., had to be imported.

Unfortunately there are few reliable statistics of outturn and consumption of wood but it is estimated the production pre-war was about 38 million c.ft. annually (excluding wood used in the rural areas and obtained locally). Of this quantity some 10 million c.ft. were exported (about half to the Near East and the remainder by rail and coastal craft to other parts of India) and the balance (28 million c.ft.) was consumed in the urban areas, factories, brick kilns, etc., in the province.

10. On an average about half the outturn of 38 million c.ft. was obtained from the reserved forests and the rest came from "other sources" such as the P. W. D. estate, privately-owned *jagirs*, *huris*, etc.

For reasons given above, the outturn from "other sources" tended to decrease and though 19 million c.ft. annually had been well within the normal productive capacity of the forests, a series of low *abkalanis* starting in 1935 seriously affected the forest estate. The general position, therefore, was not entirely satisfactory.

11. The forests largely depend on the *abkalani* because of the approximately $7\frac{1}{4}$ lakhs acres of reserves, nearly 5 lakhs are "riverain" that is they lie between the protective *bunds* controlling the Indus. The only irrigation these forests receive is, when, following the melting of the snows in the Himalayas, the river floods overtop the banks of the regular channel and spread up to the *bunds*. In consequence if the river is comparatively low during the *abkalani* only the low lying portions of the forests receive water. *Babul*, the most important of the riverain trees, can survive a year or two of drought but several successive dry years kills off much of the growing stock. As about 16 million c.ft. of the total 19 million c.ft. outturn is obtained from the riverain areas a decrease in productivity of these forests is serious.

12. The remaining $2\frac{1}{2}$ lakhs acres of forest is made up of small blocks lying outside the protective *bunds*. These forests depend for irrigation on surplus water from the canals augmented occasionally by floods following *bund* breaches. Such irrigation is irregular and the only tree which is hardy enough to survive these conditions is the slow growing *kandi*.

The inland forests formerly yielded about 3 million c.ft. annually, but in recent years, owing to the improved protective works of the P. W. D. and the increased area under cultivation, the amount of water available for irrigating these lands has decreased and the growing stock is deteriorating.

13. To increase the productivity of the inland forests estate experiments on a small scale with irrigated plantations using *assured* supplies of canal water were started about 1934-35.

Two methods were tried :

The Punjab method (as used at Changa Manga and elsewhere with much success) by which the area proposed to be brought under plantation is leased out for agriculture, one condition of the agreement being that the cultivator must level the ground. Every year one-twentieth or so of the gross area is taken back by the Forest Department, trenched at 10 ft. intervals and sown with tree seed, the seed being sown along the berms of the trenches. Trenching, sowing, irrigation and tending of the growing stock are all done by the forest staff. After the tree growth has been cut at maturity the trenches are again planted with trees without any intervening period of agriculture. *Tali* and mulberry are the chief species being raised by this system.

With the other (Sind) method the area is leased for agriculture for 4-5 years. The cultivator has to level, roughly, the land and raise, with his crops, lines of trees at 33-ft. intervals. The tree growth has to be tended throughout the lease period by the cultivator and before the end of the lease he has to dig trenches along each of the lines to facilitate departmental irrigation. This agri-silvicultural

process is repeated after the trees have been cut at the end of the rotation. *Babul* in lower Sind and *babul* and *kandi* in upper Sind are the chief species being tried.

The Punjab method yields excellent results in time but the formation period is very long and costly. The Sind method establishes the tree crop quickly and it is expected the receipts from the 4-5 years agri-silvicultural leases will cover the cost of the assured water for the whole 12—15 years rotation.

14. Except for these irrigated plantation experiments, there have been practically no attempts to develop the forest estate chiefly because of financial stringency. No one is willing to prepare carefully planned and detailed schemes if he knows no money will be made available to carry them out. Partly owing to this lack of capital outlay the average outturn of the riverain areas was only about 30 c.ft. an acre a year and of the inland forests rather less than half this amount. These figures are not impressive.

15. For some years the revenue of the Sind Forest Department averaged about Rs. 8 lakhs annually, the expenditure about Rs. 4 lakhs and the surplus also Rs. 4 lakhs.

For comparison with earnings of other provinces figures for 1938-39 are given below:

Province.	Forest area in acres.	Revenue an acre.	Expenditure on establishment an acre.	Total expenditure an acre.	Surplus an acre.	Percentage of surplus to expenditure.	Percentage of surplus to Revenue.
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.		
Sind ..	7,39,011	1 2 10	0 7 0	0 7 8	0 11 2	147	59
U. P. ..	39,50,627	1 6 1	0 7 4	0 12 6	0 9 7	77	43
Bombay ..	68,06,321	0 9 6	0 4 8	0 6 3	0 3 3	51	34
Punjab ..	33,17,633	0 11 1	0 5 5	0 12 8	0 1 7 (deficit)	..	..

(The Punjab Forest Department was expending large sums on anti-erosion schemes which were not then producing revenue though yielding valuable indirect results.)

It will be noted that pre-war Sind was spending only two-thirds of an anna an acre on the development of the estate; Bombay over twice as much, and the U. P. and Punjab eight-ten times more.

(*b*) *The War Years up to* 1945

16. Until the end of 1941 the general position in Sind did not alter much but during the past three years there have been vast changes. The demand for wood and wood products steadily rose because of the requirements of the war effort, the increase in population in the urban areas (due mostly to industrial development but partly caused by insecurity in the countryside as a result of the *Hur* menace), the scarcity of steam coal so that many industrial concerns had to depend on wood for power, etc. etc.

17. It is estimated that (it must again be stressed that the figures given are only estimates) Sind is now producing 48—50 million c.ft. of wood a year excluding that obtained locally and consumed in the villages and hamlets. This is somewhat under 30 per cent. more than pre-war.

Export to the Near East by sea had to be stopped in 1942 but export to Baluchistan (on both civil and military account) and to the Punjab (mostly on military account) continues. In all, however, exports are less by probably 5-6 million c.ft. than pre-war. Consumption in Sind, therefore, appears to have risen from about 28 million c.ft. (para. 9) to 43-44 million c.ft. which is an increase of between 50 per cent. to 60 per cent.

18. The greatest proportionate consumption increase is in the urban areas. For example, Karachi pre-war consumed annually about 4 lakh maunds of charcoal and a similar quantity of firewood ($6\frac{1}{2}$ million c.ft. wood) and now requires more than 12 lakh maunds charcoal and 8 lakh maunds firewood (18 million c.ft.) which is an increase of nearly 300 per cent. Amongst the reasons for this, are

expansion of population, shortage of oil, steam coal, etc., but probably one of the chief causes is the improved standard of living due to greater prosperity.

19. As prices for agricultural produce rose and "the-grow-more-food" campaign started, the demand for cultivable land increased and vast areas formerly under tree and scrub growth have been cleared and this process continues. The rates for wood have also increased greatly and *huri* owners, etc., have been encouraged to fell their plantations. In consequence outturn of wood from "other sources" has continued at a high level but there has been little replacement planting and it is obvious, therefore, that the supply of wood to the main markets from these sources will soon decline from a flood to a trickle.

20. More serious still is the shortage of wood in the rural areas. In parts of the Thar Parkar district cowdung is now being used regularly for domestic heating and near Umerkot the trees in the desert are being cut to supply the town and local brick kilns with fuel. In other districts also the situation is bad and is getting worse. There is still a considerable amount of scrub and small-tree growth in the Sind countryside and in some areas such as the riverain lands outside the reserved forests, the Makhi *dhandh*, etc., there are ample stocks but these supplies are of little general use as the cultivator requires easily accessible sources of wood.

21. So serious is the situation likely to become in the near future that a proposal was submitted to Government in 1944 that all *jagirdars* and *zamindars* owning estates of 100 acres or more should be compelled by legislation, amendment of the Land Revenue Code or other means to keep $7\frac{1}{2}$ per cent. of their land under tree growth. Official opinion is that some action on these lines is essential and this subject will be discussed later in the note.

22. In order to develop the P. W. D. estate as fully as possible a suggestion was made that the Forest Department should manage the tree growth on these lands as is done in the U. P. The Chief Engineer agreed in principle but it has, unfortunately, not yet been possible to frame a definite scheme owing to the shortage of forest staff.

23. A provisional working scheme for systematic roadside avenue planting was submitted to the Superintending Engineer, Roads, last year and on the main Hyderabad—Sukkur road some experimental planting has started on a small scale. Briefly the proposal is that one species of tree shall be planted in each mile length as this will ensure an unbroken shade line for a long distance. The silvicultural management of the trees will also be simplified if the crop is not mixed.

A suggested succession for a 20-mile stretch was made as under :

Mango, *tali*, *gidamri*, *siris*, *jaman*, *tali*, *rain*, *gidamri*, *nim*, *pakar*, mango, *bahan*, *tali*, *arjun*, *gidamri*, *jaman*, *siris*, *tali*, *gidamri* and *nim*.

A further suggestion was that near each milestone a small group of flowering trees or shrubs shall be planted for decorative effect.

24. During the past few years the forests have been seriously overworked. As stated in para. 10, 19 million c.ft. was formerly well within the productive capacity of the estate but the 1935-41 low *abkalanis* reduced the annual volume increment to such an extent that in 1941 it was decided that the cut, if it was to be regularly sustained, should not exceed 15 million c.ft. The requirements of the war effort, however, not only prevented any such curtailment of output but made it necessary to augment the felling programme. The 1943-44 cut was approximately 32 million c.ft. which is more than twice the "safe" figure of 15 million and nearly 70 per cent. above the pre-war average cut. The mature areas are thus being gravely overfelled and capital is being rapidly consumed. The general position, in consequence, is obviously far from satisfactory but it is perhaps not quite so serious as the above figure indicates.

25. Very fortunately the 1942-43 and 1944 *abkalanis* have been excellent. The floods have been high and sustained. All riverain forests have received deep and prolonged flooding which has had a most beneficial effect on the growing stock. During the 1935-41 poor *abkalanis*, much of the low-lying forest land was regenerated with *babul* and before the high floods came the young trees had grown sufficiently to avoid being submerged and killed by drowning. During the past three years regeneration on a very large scale has

continued and most of the higher lying forests, when the trees had died during the 1935-41 period, have now been re-afforested.

Throughout the riverain area there is now a mass of healthy young tree growth and the annual volume increment must be far greater than it has been for many years. Irrigation experts appear to agree that at present the Indus is silting its bed and if this is correct high floods can be expected even when the volume of water passing down the river is comparatively small. The prospect that the riverain area will be well irrigated for some years, therefore, appears to be good and a very large annual volume increment can, in consequence, be anticipated.

26. In recent years the *lai* areas have been heavily worked. Pre-war this wood was in small demand because *babul* (a better fuel wood) was cheap and plentiful. But with higher rates for the better wood the demand for *lai* has risen and many million c.ft. have been cut and sold. In some of the felled areas the more valuable *babul* has been introduced but elsewhere the *lai* is regenerating naturally and producing a full stocking. *Lai* grows very fast and is suitable for fuel in from 7 to 10 years so recovery from overfelling of this species will be rapid.

27. If the *abkalanis* continue to be good and there are no disasters like the frost of 1929, it appears probable that though there will soon be a serious shortage of older trees in the forests, it should be possible to keep outturn at a high level because much of the enormous stock of young *babul* will reach an exploitable fuel size in a short time and these pole crops and the *lai* areas should be able to produce sufficient fuel to meet the Sind demand in the immediate post-war period. If, however, as is only too likely, the "other sources" virtually dry up in the near future the situation will not be easy and early action to increase the tree growth throughout Sind is obviously essential whilst consumption should be curtailed as much as possible.

28. In addition to great regeneration activities the conversion of inland forests to irrigated plantations has progressed on a large scale. Pre-war this development was only in the experimental stage (para 13); now schemes involving nearly 40,000 acres have received Government sanction and preliminary operations on most of the schemes have started. Agri-silviculture (as the name implies "agri-silviculture" is merely the raising of tree seedlings in conjunction with agricultural crops) has been the method generally adopted and in the older areas the rate of tree growth has proved to be quite up to expectations. New species have been tried and some good results have been obtained with exotics, particularly with mulberry.

The irrigated plantation areas now being developed were inland forests producing not more than about 12–15 c.ft. of wood an acre a year worth perhaps annas 8–12; as irrigated plantations they are earning now more than Rs. 20 nett (in normal times it should not be less than Rs. 10 nett) an acre a year and the annual yield will average at least 100 c.ft. of wood an acre with a 12-15-year rotation. It must be pointed out, however, that these plantations will not begin to produce substantial quantities of wood until about 1955.

29. Apart from the irrigated plantations, systematic agri-silviculture has been introduced throughout the forest estate. For some years efforts have been made to encourage cultivation in the clear-felled area and blanks in the forests with the object of improving the land for silvicultural operations and obtaining the maximum financial yield. Up to 1941 the response was small but as it became more widely known that these lands were very fertile and yielded large crops the demand for in-forest cultivation leases began to rise. High prices for agricultural produce also helped to attract cultivators and competition became so keen that in 1943 it was possible to enforce the condition (which lessees at first strongly resisted) that lines of tree seedlings should be raised with the crops and be protected and tended throughout the lease period. Throughout much of the forest estate this is now the regular practice and no time, therefore, is being lost in beginning to reafforest the felled areas and blanks.

Pre-war in-forest cultivation covered only a few hundred acres and realised a few thousand rupees of revenue. For 1941–44 the results are:

Year		*Area*	*Revenue*
		Acres	Rs.
1941-42	..	16,965	1,02,352
1942-43	..	34,638	3,34,871
1943-44	..	41,808	11,32,687

The acreage in 1943-44 was about 6 per cent. of the whole forest area and this in-forest

cultivation, in addition to assisting the "grow-more-food" campaign, has usefully employed many agriculturists, contributed to rural prosperity and greatly benefited the estate.

30. Forest departmental activities have been increasing rapidly since 1941 and financial results have naturally expanded as the following figures show:

Year	*Revenue*	*Expenditure*	*Surplus*
	Rs.	Rs.	Rs.
1941-42 ..	8,90,724	3,88,729	5,01,995
1942-43 ..	15,34,330	4,23,200	11,11,130
1943-44 ..	35,52,152	7,00,174	28,51,978

In para. 29 above the remarkable increase in revenue from agri-silvicultural operations is shown. Expansion of outturn and increase of prices for the forest "cuts" have also contributed greatly to the revenue expansion. It may be mentioned that it is only in upper Sind, where the Punjab rates partly rule the market (there is no price control of fuel in that province) that prices have soared; in lower Sind rates for standing trees are not much above the pre-war levels.

31. To cope with the additional work caused by the expansion of work Government sanctioned the creation of a new territorial division (Nawabshah) and also two posts for research work divisional forest officers for silviculture and utilization. This is progress but trained forest staff is still far from sufficient for all the work requiring attention.

PART II

OBJECTIVES

(*Not necessarily in order of importance.*)

32. Establish woodlands throughout the rural areas to ensure:

(*a*) Adequate supplies of small timber for hutting and agricultural implements.

(*b*) Cheap and easily accessible fuel so that cowdung cakes need not be used for domestic heating.

(*c*) Provision of sufficient windbreaks to prevent damage by wind erosion.

33. Protect the so-called desert areas in the east of the province in order to:

(*a*) Prevent the disappearance of the ground cover of vegetation which alone prevents serious wind erosion.

(*b*) Increase the fodder supplies so that these areas can support larger herds of cattle.

34. By means of anti-erosion operations on the semi-barren hills in the west of Sind:

(*a*) Assist the control of flood waters.

(*b*) Gradually improve the soils and increase the vegetation so that these areas may become more productive.

35. Expand and develop the forests and other Government estates (such as the P.W.D. canal banks, etc.), to:

(*a*) Provide adequate supplies of charcoal and firewood for the urban areas.

(*b*) Eventually produce most of the timber required in the province for housing, etc., and for industries which consume timber such as manufacture of sports goods, etc.

(*c*) Meet the demands of the valuable export fuel market.

36. Provide amenities by establishment of roadside avenues throughout the province, green belts around all the expanding urban areas, etc. etc.

37. It is not easy to estimate the quantity of wood that must be produced to satisfy Sind demands (excluding the rural areas which will, it is hoped, obtain their supplies from local sources). The population in the towns is rapidly increasing and the urban standard of living is rising and when the new barrages are constructed this expansion will continue even more rapidly.

In normal times other fuels for domestic heating will be available; but if industrial development takes place on the scale envisaged in many of the post-war development plans coal and oil will be required for industry in such enormous quantities that there may not be any cheap alternative fuels to charcoal and firewood for domestic heating. Whatever happens there is no doubt more wood will be required than before the war when the Sind consumption appears to have been about 28 million cu.ft. (para. 9). An annual production of 55–60 million cu.ft. (twice the pre-war consumption and 50 per cent. more than pre-war outturn) within 2-3 decades is not an unreasonable target. Should Sind not

require the full quantity within the period mentioned there is little doubt that the export markets will absorb any surplus.

Half the pre-war outturn of about 38 million cu.ft. (para. 9) was obtained from " other sources " which are not likely to have any large surpluses in future ; in consequence the forests will have to produce the bulk of the 55–60 million cu. ft. required and production (pre-war 19 million cu.ft.) will have to be increased three-fold.

(*To be concluded.*)

HOW TO GROW GOOD LAC

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The object of this paper is to give in detail the ways by which Lac, good in quality and quantity, can be grown. This can be done by the following methods:

(A) Proper working of the host trees:

1. Correct pruning; 2. Selection of brood; 3. Correct infection (inoculation); 4. Correct reaping or cropping.

(B) Control of enemy insects of lac and lac-insects.

(A) 1. *Correct Pruning.*—For every host tree the rules for pruning are different and as such each species must be pruned accordingly. Following are the general rules of pruning:

(1) The general health and vigour of the tree should be maintained.

(2) Cutting should be done in such a way so as to give a good shape to the tree and allow plenty of room for the new shoots.

(3) All dead and diseased branches should be cut.

(4) The thinner the branch, the nearer to the main stem should it be cut.

(5) Pruning should be done with sharp knives.

(6) Cuts should be clean.

(A) 2. *Selection of Brood.*—After the host is pruned and is ready for infection, the next important step to be taken is to select the best brood as far as possible free from parasites and predators. Only healthy lac should be selected. Brood lac showing webs and domes of the enemy insects or holes caused by them should be rejected. In the *baisakhi* and *jethwi* lac pitted and a dry yellow appearance indicates that the lac insects have died due to heat and drought. Such lac sticks should not be used for brood. Lac sticks bearing either poorly developed sparse lac cells or poorly developed encrustation should also be avoided.

(A) 3. *Infection or inoculation.*—This is the process of introducing lac larvæ on to a tree on which it is proposed to grow lac. This is done either by artificial infection or by natural infection.

Artificial infection.—While infecting the trees artificially, brood lac sticks, single or in bundle. are put on the host trees and tied. The lac insects come out and settle on the new shoots. The bundles should be put on the forks to give more contact with the shoots. Tying should always consist in $1\frac{1}{2}$ knot so that removal may be easier. The number of bundles, sticks or baskets put on the trees should be counted and recorded to help the correct removal after the settlement is over. All brood lac put for infection should be carefully removed and in no case should it remain on the tree, as parasites and predators continue to come out from the brood lac, even after all the lac larvæ have swarmed, and infest the future crop. The time for keeping the brood lac on to the tree is 2—3 weeks in normal conditions. The proper quantity of brood lac to be put on the tree is estimated to be one healthy lac stick as sufficient to infect about twelve times its length.

Natural infection.—In this the crop is cut partly and the rest is left on tree to serve as brood to infect the same tree for the next crop. No regular pruning and infection is done.

Due to the following disadvantages natural infection should be discouraged:

(1) Uniform infection is not possible.

(2) The host tree is always under infection and does not get periodical rest, with the result that the host tree does not produce good shoots.

(3) The lac is less valued, because in natural infection all dead and healthy lac from the previous crop is mixed in it.

(4) The important point to note is that natural infection gives rise to increase in parasites and predators.

(A) 4. *Reaping or Crop cutting.*—This is done when the crop matures. It should be done completely and no lac should be left on the tree. Before reaping is carried out it is very necessary to know when the crop will mature, as premature crop cutting deprives the female lac insect of its food supply and therefore does not produce healthy and the maximum number of young it is capable of producing otherwise. The quantity of lac produced will also be less. The crop should not be cut late also, as by late cutting lac will swarm on the mother tree itself and during the process of cutting, selection and infection a good number of larvae will be lost and future settlement will be poor.

Therefore, it is important to know the correct time for cutting the lac. This varies from place to place and from year to year in different crops. The following are some practical hints to know the swarming time approximately :

(1) When a female insect is crushed between the fingers, the body contents show granular appearance. This granular appearance becomes more and more prominent as the time of swarming comes nearer ; in *baisakhi, jethwi* and *katki* crops 2-3 weeks before swarming and in *aghani* 5-6 weeks before swarming.

(2) Cracks appear in the encrustation ; in *baisakhi, jethwi* and *katki*, 2-3 weeks before swarming and in *aghani* 4-5 weeks before swarming.

(3) Dry appearance of the encrustation. The encrustation looks dry and is easily peeled off from the twig about two weeks before swarming.

(4) Appearance of yellow area on the female lac cell.—The lac insect is dark red and its covering of lac is yellow and translucent. When the female lac insect has fully matured, it contracts its body and becomes separated from the lac test and thus a space is caused between it and its test and this portion of the test looks yellow. The eggs are laid in the space so caused. The yellow area appears at the posterior end of the cell and should be looked for behind and below the anal tubercular opening. This area gradually increases in size and in about eight days half the insect looks orange. It is at about this stage that the lac larvæ begin to come out. About five days before swarming starts, the yellow area is one-fourth the size of the lac cell and about three days before swarming one-third the size of the lac cell. This is the most accurate and reliable method to find out the swarming time and the time of crop cutting. In large areas the crops may be cut five days before swarming and in small areas three days before swarming.

(B) *Control of Enemy Insects of lac.*—The annual production of lac is about 10—17 lakh maunds, about 40 per cent. of the crop having been destroyed by the enemy insects. The enemy insects can be broadly grouped into parasites and predators.

(1) *Parasites.*—Parasites are small winged insects called chalcids. They lay eggs in or on the body of the lac insects. The larva feeds on the lac insect only and not on the lac produced by it. The adult comes out by biting a hole in the lac. The damage by parasites is 8 to 9 per cent.

The following is the list of the common parasites :

(1) *Tetrastichus purpureus ;* (2) *Eupelmus tachardiae ;* (3) *Parechthrodryinus clavicornis ;* (4) *Erencyrtus dewitzi ;* (5) *Tachardiaephagus tachardiae* (Y2) *;* (6) *Coccophagus tschirchii ;* (7) *Tachardiaephagus somerville* (Y4) *;* (8) *Marietta javensis.*

(2) *Predators.*—Predators are insects which lay their eggs on or near the lac cell. The larva enters the lac cell by biting a hole in it

and goes on feeding on the lac insect and its test and making tunnels and galleries lined with silk excreta and pieces of the encrustation. The larvae pupate in these galleries.

COMPARISON OF HABITS AND DAMAGE CAUSED BY THE PARASITES AND PREDATORS

Parasites

(1) They lay eggs inside the lac cell in or on the body of the lac insect.

(2) Each parasite damages only one lac insect.

(3) They feed on lac insect only.

(4) They damage 8-9 per cent. of the insects.

Predators

(1) They lay eggs on or near the lac cell.

(2) Each predator damages many lac insects.

(3) They feed on the lac insects and also on the lac produced by them.

(4) They damage 30—35 per cent. of the lac insects and the lac produced by them.

Among the predators there are two major predators responsible for practically the whole of the predator damage. They are: (1) *Eublemma amabilis*, and (2) *Holcocera pulverea*, Both of them do more damage to the *katki* and *aghani* crops than to the *baisakhi* and *jethwi* crops. *Katki* is affected more than *aghani* and *aghani* is affected more than *baisakhi*.

In the following diagram the crops are marked serially according to the intensity of predator attack:

- *Rangeeni*
  - *Katki* I — June-July to Oct.-Nov. → Aug.-Sep.
  - *Baisakhi* III — Oct.-Nov. to June-July → Jan.-Feb.
- *Kusmi*
  - *Aghani* II — June-July to Jan.-Feb. → Aug.-Sep.
  - *Jethwi* IV — Jan.-Feb. to June-July. → March-April

M A L E E M E R G E N C E

Explanation.—When *katki* crop is cut the predators emerge from the *katki* crop and go to attack the *aghani* crop in the field. When *aghani* crop is cut the predators come out from *aghani* and attack *baisakhi*. This is the reason why *kusmi* and *rangeeni* crops should not be grown side by side.

The damage caused by insect enemies can be considerably reduced by the following control measures:

(*a*) Cultural measures.
(*b*) Artificial measures.
(*c*) Biological measures.

(*a*) *Cultural Control Measures*—

(1) Lac intended for use as brood lac should be cut as near to the swarming period as possible. Not more than a week before.

(2) In choosing lac for brood, healthy lac showing minimum enemy attack should be selected.

(3) Lac tied to the trees as brood should be removed as soon as the trees are sufficiently covered by the lac larvae and in no case should it be allowed to remain on the tree for more than three weeks.

(4) Natural infection should be discouraged.

(5) All lac cut from the trees and not required for brood lac and all brood lac after use should be immediately scraped. This itself will destroy many larvae and pupæ of enemy insects.

(6) Stick lac should be converted into seed lac (washed lac) as the predators breed on the stored lac also.

(7) The *rangeeni* and *kusmi* crops should not be grown side by side.

(*b*) *Artificial Control Measures*—

(1) *Water immersion.*—This method has

been tried at the Indian Lac Research Institute, Namkum, Ranchi, and found to be very useful especially for the poor people who cannot afford to go in for other expensive and elaborate methods. The best way to carry out this method is in running water in streams or rivers. It can be conducted in village ponds also where water level should be over two feet above the immersed lac stick bundles. The bundles should remain in water for full three days. By this time all the lac insects together with parasites and predators which inhabit lac are suffocated to death, because they are not water insects and cannot live under water. On the fourth day the lac bundles should be taken out from water and put on grass to drain off water and dried under shade. In rainy season the immersed lac sticks should be spread in warm rooms and dried.

Lac treated in this manner is in no way inferior to the untreated lac. But if sufficient care is not taken, the stick lac and the shellac prepared from it may look darker in colour.

The advantage of this method, besides killing enemy insects, is that the lac can be easily scraped from the sticks. The water in which this treatment is carried out should not be used for drinking purposes.

(2) *Heat Treatment.*—In this method lac sticks are heated in a room to different ranges of temperature to kill the enemy insects. The experiments are under investigation and nothing definite can be said at present.

(c) *Biological Control Measures*—

These include destroying the enemy insects of lac with the help of other insects which feed on them. Therefore such insects are beneficial insects. Biological control of parasites seems to be impracticable and the damage by parasites is very small to attempt biological control. The biological control of predators is to control the two major predators *Eublemma amabilis* and *Holcocera puloerea*. Following insects may prove useful in controlling the two predators:

(1) *Microbracon greeni*—Ecto-parasite of *Eublemma amabilis* larva.

(2) *Apantelis tachardiae*—Endo-parasite of *Holcocera puloerea* larva.

(3) *Pristomerus testaceicollis*—Endo-parasite of *Holcocera puloerea* larva.

Microbracon greeni are bred in the Indian Lac Research Institute and adults are being released every week in the control and experimental lac areas. From such areas weekly lac samples are collected to examine the effect of these released insects on the predators.

The following figures from the annual report of the Indian Lac Research Institute for 1943-44 will give a rough idea of the effect of biological control on the yield:

Name of the Crop	*Brood to Yield ratio in control areas*	*Brood to Yield ratio in release areas*
(1) *Jethwi* ..	1 : 3·0	1 : 4·7
(2) *Aghani* ..	1 : 4·5	1 : 5·7
(3) *Katki* ..	1 : 2·2	1 : 2·6
(4) *Baisakhi* ..	1 : 3·1	1 : 1·8

(Due to some reasons the ratio in the release areas is lower than in the control areas.)

In addition to the insects, animals such as rats, monkeys and squirrels, also damage lac to some extent. They break the incrustation from the twigs and throw it on the ground. Lac can be protected from such damages by keeping watchers to guard the lac area.

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NEED FOR PLANNED FOREST POLICY*

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Second in importance, perhaps, only to the activities connected with the defence services are the post-war reconstruction schemes, fostered either by the Governments or private interests. The abnormal conditions brought about by this global war which is running through its fifth dreadful year have resulted in material dislocation in every walk of life. The people who, directly or indirectly, have suffered because of the war look forward to a better world to live in. The immensity of the task of rehabilitation becomes apparent when we take stock of the hundreds of professions, economic interests and social orders, all of which have contributed to the common struggle and expect, as a matter of right, a share in the fruits of victory. Just as the individual, rendered homeless by bombs, will be provided with an equally good if not a better house, the setback suffered by the social and economic structure will also require to be made good. To devise measures for achieving this end so many post-war reconstruction committees have, or are likely to, come into being. The meeting of the Policy Committee (No. 5) held in June, 1944, at Simla to discuss agriculture, forestry and fisheries problems was in pursuance of this policy for post-war planning.

The resolutions relating to forestry and land development passed by the above committee merely reiterate the problems and the ways to tackle them, on the lines stressed by the forest departments from time to time. The novelty of the proposals lies principally in the recognition of the necessity for co-ordinating the land reclamation and improvement measures on an all-India basis, and for bringing a minimum percentage of the area under forest in each geographical unit. Criticisms and concrete suggestions were invited from the provinces. The proposals are in conformity with the Inspector-General of Forests' note on post-war forest policy for India, and are likely to be generally accepted. The object of this article is not to dilate upon the various points made out and the urgency of their adoption as a basis of policy. It is an attempt to draw a borderline between the ideals enunciated and the difficulties attending their realization, and to include a few other problems that are either the outcome of war or already overdue for solution. The more pressing of them deserving immediate attention may be summarised as:

1. Over and advance-fellings in most of the timber forests to meet the ever-increasing demands of the Supply Department, and consequent deviations from the working plans.

2. Likely shortage of constructional timber and woods of miscellaneous utility which have been tapped to the point of practical unavaliability in required sizes.

3. Fall in gross and net revenue after the war unless suitable measures are taken well in time to stabilise them at least in the neighbourhood of pre-war figures.

4. Reclamation and improvement of the land which is a *sine qua non* of flourishing agriculture and, therefore, of the prosperity of a vast majority of the Indian people.

5. Provision of fuel forests within reasonable access of each village habitation so that the much-needed cow-dung may be released for its proper use as manure.

6. Regulation of grazing and improvement of pasturage and livestock.

Regardless of what the final outcome of the Policy Committee's deliberations is, and to what extent the recommendations are acceptable to the provinces and the states, the forest departments, even as at present constituted, staffed and financed, will find that at least the first three items are deserving of their careful consideration and it is their inescapable responsibility to find the way out.

Taking them in the above order, we usually hear that the requirements of the defence services rightly have priority over the implications of management, as envisaged in the working plans. Quite so; but it does not

* The article by Mr. Habeeb Khan is a resume of what everyone knows should be done and what is planned. It will be interesting to hear in due course what has actually been achieved.—Ed.

mean that the prescriptions should be disregarded any more than is absolutely necessary to tide over the emergency. May it pertinently be asked if there is not an evidence of undue leaning towards a policy of drift which is the negation of the profession of a forester? It is admitted that forestry is not an exact science and the management of the forests does not lend itself to a mathematically accurate check in order to judge the appropriateness or otherwise of a certain method of working. Mistakes that we make will not be exposed till decades after we are gone. That is why the real test of the forester's integrity lies in his ability to safeguard the future productivity of the forests.

Forests have made and are making their contribution to the common cause. They have been taxed beyond their capacity and stand in need of reconstruction as much as a bombed town. The capital that has been removed must be replaced. Most of the cultural and regeneration operations that were normally carried out are held in abeyance because the staff can ill afford time and energy except for arranging the supplies of the forest products for the war purposes. Regeneration of the felled forests will be much in arrears and the revision and recasting of the plans an immediate necessity when the war ends. Increased trained staff and funds will be required to get down to the job as soon as the strain of the war work is over.

The heads of the departments should secure definite guarantees from the Governments that necessary funds, staff and other facilities will be promptly sanctioned; and just as no technicalities of the management are allowed to interfere with meeting the heavy demands for timber, there should be no hair-splitting over financial matters for redeeming the over-felled forests. While making commitments to the Governments they ought to impress upon them that while the income is partly due to high royalty rates, it is primarily due to overfelling, which is a liability to be paid back after the war in the shape of reduced yields in order to make up for the war-time overcut and high budget allotment for regeneration and cultural works. Reserve funds should be created out of the revenue accruing from excess fellings as has been done in some provinces. Recruitment and training of the staff needed for the execution of the post war schemes should be taken up right now, because, as is well known, it takes two years to train an officer after his graduation. We are told that neglect in the matter of timely training of the staff was responsible for acute shortage of the trained personnel throughout the British Empire after the last great war. It is hoped that the mistake will not be repeated. Promptness in this respect is a crucial test of how the provincial and state governments feel about future of the forests. The expansion of the classes at Dehra Dun, both in the Indian Forest College and the Indian Forest Rangers College, reflects credit on and shows the keenness of the central Government in the forest administration.

Revision of the working plans in the period immediately following the war should be entrusted to the best available officers who are well-up in management. Future yields have to be carefully worked out and regulated in view of the abnormal condition of the crops. Precautions will be necessary to see that no juggling is done with formulæ, in order to bring the yield to a predetermined figure and thus make the revision an excuse for further overfelling. Such a tendency should be deprecated and strictly guarded against, as also any attempts to introduce prescriptions that may be of doubtful value, but satisfy individual predilections. Amelioration of the over-worked forests under sound silvicultural principles should be the ruling criterion. Revision of the plans will no longer be a stereotyped affair, but one demanding originality and hard work on the part of the working plan officer and thorough check and scrutiny by the working plans conservators and the chief conservators.

The plans for the most of the important timber divisions will be simultaneously due for revision irrespective of their sequence in the normal course of things. It is obvious that because of the limitations of the staff and inadvisability of curtailing fellings drastically till the new plans are ready, the officers in charge of the plans must frame in advance a tentative programme for revision and have some idea about the yields to be realized during the interim period. The extent of reduction in the annual possibility from each working circle and felling series, though a controversial point should depend on the intensity of overfelling to which the forests in question have been subjected. For instance, the yield from

the unworked compartments of the working circle can be realized on the basis of the yield given in the current plan and on the assumption that the volume removed in excess of the maximum permissible limit will be spread over ten years or more, depending on the extent of overcut and total capacity of the working circle. The fixation of the period in which excess removed is to be returned to the forests should be governed by the expediency of providing reasonably big annual coupes which would satisfy the minimum requirements of the timber lessee and fetch fair royalty. This course is purely arbitrary and should cease as soon as the plans are available for execution. The period for which this tentative procedure may remain in force will vary from 2 to 10 years, depending on the year after the war when the revision is taken up, provided all the plans are revised within 10 years of the termination of war. The choice of the divisions for early revision should be subject to the extent of overfelling, the most heavily worked divisions being taken up first, which will mean the more important timber divisions. It would be preferable if the heads of the departments decide the case of each division, both as regards the revision of the plan and the reduction in volume, in consultation with the working plans and territorial conservators, territorial D. F. O. and the author of the current plan.

SHORTAGE OF TIMBER AND WOODS OF GENERAL UTILITY

The fear of shortage of a majority of forest products, particularly timber, seems to be well-founded. It, however, generally escapes notice that when we speak of the shortage of timber we inadvertently refer to only a few common timber species which held the market before the war and continued to be exploited during the war. In spite of the presence of scores of timber species in India, only teak, *sal*, *deodar*, *kail* and *gurjans*, besides a few others of minor significance, have been the popular species for constructions requiring large-sized scantlings. Whereas substitutes for trees put to miscellaneous uses like packing cases, lorry bodies, munition boxes, etc. were sought after because of the limited stock of the suitable species and were found, such a contingency did not arise in case of the main timber trees, thanks to the apparently very large resources of them. It is the forests of these species that have suffered the greatest strain which will inevitably cause a fall in the yield of their timber after the war.

Timber is bound to play as important a role in the period of reconstruction as in war. Many projects involving the use of timber are being put off till after the war. Rail and road expansion, town planning on modern lines, construction of better houses of improved designs, expansion of industries and industrial colonies for the factory workers, hydro-electric works and the extension of the telephone and telegraph lines, to mention only a few important ones, are items in the programme of post-war development, that will utilize large quantities of constructional timber. India has practically escaped the horrors of bombardment and has only a few, if any, ruined habitations to rebuild. Because of its remaining unscathed, however, it will be expected to help in the rehabilitation of a number of the Empire countries. The drain on the resources of timber is, therefore, not likely to slacken. These outlets for the timber will be additional to the nôrmal requirements of the country on the pre-war level. Shortage of timber appears in true perspective when we take cognisance of the fact that most of the commercial timber forests were worked to the full capacity even before the war started. Increased demands and low yields will be a stern reality confronting the foresters at the advent of peace. These two apparently incompatible factors need to be harmonised.

India is rich in timber trees but, as in other spheres of life, is prejudice-ridden. Timber market is in favour of certain species because they have the sanction of long-established use behind them, and is against others without having tested or tried their working qualities. The forest departments have also a share of blame because they too tacitly acquiesced in the professed merits and defects as evinced in the trade. The department, though quasi-commercial in nature, never invoked the technique of commerce to popularise the unfamiliar species. This has been due mainly to the extensive forests of the favourite species and a steady demand for them. Or was it due to the false sense of official prestige—so common in India—which did not like to suffer a climb down from the privileged position of a government officer to that of a businessman ? War has created conditions which have given

a rude shock to this complacent attitude. We must change the outlook and wake up to the realities.

To avert the timber crisis, an entire re-orientation of policy is called for. Methods of trade should be imbibed, encouraged and widely practised. Generally speaking, all the provinces, especially those having evergreen and semi-evergreen forests, can find one or two, if not more, timber trees occurring in sufficiently large proportions, which possess qualities not inferior to those of the trees ordinarily in demand. They should have their qualities properly tested at Dehra Dun and popularise their timber among the timber traders and consumers by means of the two most effective instruments of trade, *viz.*, propaganda and advertisement throughout the sphere of their timber market. This is the only way to remove prejudice from the minds of the people. Secondly the forest departments should formulate it as a basis of the policy that the deficiency in the yield of the principal species will be made up by these species possessing identical qualities. The people will then have no alternative but to accept and give them a fair trial.

Reconnaissance surveys should be undertaken forthwith to map out and estimate the approximate yield capacity of forests of auxiliary species, so that immediately after the war they may be exploited along with the main species. To begin with, areas entailing low extraction and transport costs should be selected because heavy working charges are not conducive to the success of the new undertaking. In the event of the lessees not coming forth, there need be no hesitation in working the forests through departmental agency, provided the qualities of the timber for the purpose in view are up to the generally accepted standard. Opportunities offered by the war should be grasped and utilized to the maximum advantage for creating a market for these species before conditions settle down to normal inflexibility and bias.

Even after the war, a certain measure of control will be essential, firstly to avoid speculation in the timber trade and secondly to ensure equitable distribution of timber throughout the country. A number of timber-producing units which have been working conservative yields did not resort to over-felling and will continue to keep the supplies of timber sustained, while others will have to cut down the volumes considerably. There are likely to be regions requiring more timber than can be supplied by the forests of the adjoining provinces or states. Under the circumstances, it is advisable to hold back a certain portion of the favourite timber from the former and thus encourage the consumption of subsidiary species both from the surplus and deficient units. Taking Kashmir as an illustration, we shall be in a position to supply *deodar* and *kail* to the extent we have been doing hitherto. Because of overfelling for war purposes in the N. W. F. P. the Panjab and U. P. forests of these species, there will be a general shortage of *deodar* and *kail* timber in areas catered for by the above provinces and their adjoining states. The factors for speculation therefore exist, and control of distribution for some time after the war will have a salutary effect on the trade. Kashmir can withhold a certain portion of the *deodar* and *kail* yields and thus encourage the tapping of its fir forests which form about 55 per cent. of the coniferous forests of the state. Co-ordination between the surplus and the deficient units is also essential otherwise the former may give way to the temptation of making the best of the brisk demand for their principal timbers.

Classification of the commercial and uncommercial forests also needs to be revised. Many of the well-stocked and otherwise suitable forests were considered uncommercial because of their being away from the main floating streams in the hills and from the rail or road-head in the plains, involving prohibitive extraction and carriage charges. Advantage should be taken of the high prices of timber obtaining now. These forests should be taken up before the prices show a downward trend, rendering them again uneconomical. In Kashmir for example, a number of fir forests situated over two miles away from the principal streams, which were considered as uncommercial by the working plan officers because of low price of fir timber and high transport rates, have been readily sold in war-time and have fetched unexpectedly high royalties. There is still ample chance of working similar forests everywhere because the timber prices are not likely to register a substantial decline for some years after the hostilities are over.

As regards woods of miscellaneous utility, particularly the soft hardwoods, a deficiency

was experienced even during the war and a number of suitable substitutes were found out. The seasoning and timber testing sections of the Forest Research Institute have done much exploratory work in this direction and can further help the forest departments.

FALL IN THE FOREST REVENUES

The present-day boom figures are bound to fall. This factor coupled with the reduced yields will bring about a substantial decline in the forest revenues, which is likely to give a headache to the finance departments of the provinces and states where the forests contribute a major portion of the state income. Timber has been the mainstay of forests finance and will continue to occupy the same privileged position for a considerable time to come. There is, however, no reason why the resources of the minor forest produce should not be brought to a high stage of productivity. The paper pulp industry is a very feasible proposition for the units owning fir forests which are not usually worked to their full capacity. Plywood and match factories are a further possibility, particularly in regions other than those of the temperate forests. We must start on the principle that the last word has not been said on the selection of suitable species for these industries, or for that matter, for the manufacture of the bobbins, pencils, penholders and sports goods. Many neglected species possibly await a trial to prove their utility for one or the other of these purposes. Perusal of the books on the uses of the Indian timbers and other forest products reveals that for different purposes there are quite a number of 'probables' besides the species actually used; and at least in some forests the material will be available in the required quantities.

During the war a number of new uses have been discovered for a variety of forest trees. It will be really unfortunate if a relapse is allowed to set in after the high war-time demand is over.

Readers will be interested to know how the Kashmir Forest Department proposes to stabilise its finances after the war. As soon as the normal conditions return, the installation of a paper mill for utilising the vast resources of the fir forests is likely to receive early attention. Rifle half-wroughts which, till recently, used to be prepared only from walnut (*Juglans regia*) timber are now made from maples (*Acer spp.*) and birdcherry (*Prunus paddus*) as well. This has given a further lease of life to the half-wroughts factory which had a very uncertain future on account of the depletion of the walnut stock. The department is running its own willow bats and rosin and turpentine factories for which the supplies of willow timber and resin respectively are being planned on systematic lines. Cultivation of *Pyrethrum cinerarifolium* (an insecticidal exotic) has, to date, been made over 1,500 acres and with further extension on an ambitious scale will be the main source of additional revenue to bridge the gap between the war and the peace figures. *Kuth* (*Saussurea lappa*) will again come into its own with the termination of the Sino-Japanese war which will synchronise with the defeat of Japan by the Allies. Schemes are afoot for regulating the extraction of the scores of herbs of medicinal use in which the forests of the state are profoundly rich. The more important of them, like *Atropa acuminata, Aconitum heterophyllum* and *Podophylum emodi*, are to be artificially cultivated. Thus it will appear that all possible preparations are being made to meet the hiatus in revenue. Though the fall in the timber and minor forest products royalties is inevitable, we are confident that the income will not be lower than it was before the war. In case of administrations like Kashmir, where the forest income is the largest single source of the state revenues (the forest department contributed Rs. 101 lacs out of a total revenue of about 380 lacs in Samvat 2000, corresponding to 1943-44) the part that the forests play in the state economy is self-evident.

The heads of the departments are responsible for preparing the finance departments to accept the viewpoint that the revenues must fall after the war, because the people who think purely in terms of figures may not be open to conviction at the eleventh hour when confronted with an unexpected landslide in the forest revenue.

RECLAMATION OF LAND SUBJECT TO EROSION

Deterioration of the land following denudation of the hillsides and consequent erosion are problems of long standing. They have remained neglected in the past due to non-realization of the disastrous effects that come

in the wake of erosion and in the recent years to the apathy of the governments. Land has suffered enormously from this neglect. Sporadic attempts at reclamation in the Panjab, U.P. and possibly in Bengal cannot be attributed to a far-sighted policy. The conditions in certain parts of these provinces had reached a stage when the effects of erosion manifested themselves in the worst form, and no alternative was left but to take up preventive measures. Other provinces and some states also became alive to the baneful effects of neglect and to the urgency of timely action. Achievements, if any, are more in the nature of demonstration plots than anything else. Such patchwork, resulting from half-hearted action, lack of long-term policy and funds is of very limited use indeed. Interdependence of the different parts of India is not probably so strongly emphasised by any other single factor as by the expediency of joint efforts at controlling erosion.

It will serve no purpose to enumerate the causes and effects of erosion which are well known to the readers of the *Indian Forester*. It is, however, a sad comment to make that the gravity of the situation is not fully appreciated by the majority of the people who really count in the higher counsels of administration. Experts on land management, forests and agriculture are not seriously taken and their recommendations, technically infallible, are considered in no other light than theories which the experts are wont to put forth to justify their existence. It is, however, gratifying that there are signs of indifference giving way, though much leeway is still to be made up. The administrators are responsible to see that the interests of the coming generations are not jeopardised by lack of foresight and they owe them the duty to arrest the appalling rate at which precious soil is eroding away. Enough harm has already been done by this slow but sure enemy of the land.

Constitutional implications, interests of the private forest owners, reluctance of administrations who do not look far ahead, apportioning of the liability for reclamation of the ruined areas, differences of opinion as to the channels for the co-ordination of the efforts and scores of other points will need to be reconciled. Every new reform—and this is the most vital one for an agricultural country like India—has to face opposition from various quarters, which invariably melts away before determined action. To cure this malady, the central Government is the only competent authority who can take up the job with determination and see it through. It should be classed and dealt with as a national emergency. The provinces and the states should be made to align themselves with an all-India policy. Excuses of lack of funds should not be allowed to thwart the object, nor should any unit, big or small, be left out while the proposals are framed. A small hill state, though politically insignificant, in whose territory the headwaters of two rivers lie, should be reckoned on the same footing as the biggest province. Need for its association in chalking out the schemes which it will be required to execute is obvious. Consequently in the discussion of a subject of such a far-reaching importance as land management, omission of the states, in which the problem of erosion is generally more acute than in many provinces, can hardly be justified.

As practically every province and state has each its erosion problem to a more or less degree, inclusion of all of them in a single committee or conference is not practicable. They can be grouped on regional basis, each region comprising of the territories lying in the same sphere of drainage. For instance, all the areas whose water drains into the Indus or its tributaries should constitute one group. Further subdivision can be made by associating only the adjoining states and provinces having problems of common or reciprocal interest and excluding others whom those specific problems do not concern.

The Policy Committee have provided for the establishment of the Land Utilization Board and recommended the survey of the problem in all its aspects. The board will act as the central guiding and co-ordinating authority for the constituent units. In final formulation of the policy the areas should be classified in order of priority according to their need for preventive and reclamation measures. The operations will have to be subsidised in small principalities and states whose finances cannot afford heavy outlay of capital. A liberal allotment of funds and technical staff should be made by all the administrations. Necessary legislation may have to be enacted for mere reliance on the civic sense of the people is likely to frustrate the object. To the

tradition and religious-ridden Indian villager, nothing matters unless it has the authority of religion, custom or law behind it. Secondly the job must be entrusted to the departments which have the technical background and aptitude for it. It is the experts' job and can be properly done by them alone.

FUEL FORESTS FOR THE VILLAGERS

Agriculture, the backbone of Indian economy, besides depending on crude and unscientific farming practice in vogue for centuries, suffers from the handicap of non-availability of farmyard manure which is burnt as fuel in many villages. Exact statistics about the loss to the crops as a result of inadequate manuring are not available ; though there is no denying the fact that it is considerable. Not that the villager has a special preference for cowdung to wood fuel, but because of the absence of the latter in the neighbourhood of the villages and of high prices beyond his means near the towns, he falls back on cowdung as a handy substitute. He is incapable of realizing that the apparent freedom from spending for fuel more than detracts from the yield of his crops. In this case, too, he derives strength from the practice dating back to his great-grandfathers.

Besides improvement of the land, by terracing in sloping localities for example, its productive capacity can be greatly increased by diverting the manure from the fireplace to the field. Scientific farming methods, use of better qualities of seed, rotation of crops and proper manuring will go a long way in improving the cultivator's standard of living. Unless recourse is had to scientific agriculture, the swelling population of India, to which the cultivator adds the largest share, will make living more miserable. Provision of fuel forests within easy reach of the villages or of fuel at nominal prices is the proper remedy for releasing cowdung for the fields and the onus of fulfilling this want falls on the Forest Department. Widespread propaganda to persuade the cultivator to plant up a certain part of his land for producing fuel is the first step. Even though he can grow his agricultural crops in the same area for at least a few years along with the fuel species, it is not likely that he will willingly take to this novel idea. Fuel forests must, therefore, be raised near the habitations. There is usually plenty of uncultivated land available, particularly village *shamlats* which can be utilized for the purpose. The project will involve considerable expense which will be paid back within a short period. It should be pushed through with the aid of the Agriculture Department, which must contribute handsomely to finance it. The problem is not generally acute near the forests but there, too, the villager burns a certain part of the manure. Well-organised propaganda and persuasion, preferably through the Rural Development Department, should convince him of the harm he is doing himself. Some years back the U. P. Forest Department created the post of a forest development officer and have done a little pioneering work. Their experience can be drawn upon when the schemes are put into practice.

IMPROVEMENT OF PASTURAGE

The prosperity of the cultivator depends primarily on the fertility of his land and the quality of his livestock. The poor quality of the cattle that the Indian cultivator keeps is a definite liability to him and needs sorting out and improvement by encouraging superior breeds. Forests come into the picture in relation to the pasturage they provide. Nearly all the cattle in the adjoining villages subsist on grazing in the forests. In a majority of cases, especially in the hills, the number is supplemented in summer months by goats, sheep, ponies and buffaloes belonging to the migratory graziers who invariably move to the high-level pastures. Consequently the incidence of grazing is extremely heavy, more so in the period of active vegetative growth. A large number of pastures, lying on or near the principal routes, are grazed by more than one variety of cattle in the season.

Little has so far been done to control or improve grazing. Along with the deterioration of the pasture lands, the livestock have also suffered for lack of adequate feed. Unrestricted grazing is also responsible for extension of the blanks in the forests. Forest departments should take steps to exercise control over the incidence and season of grazing. Introduction of better species of fodder grasses, encouragement of stall-feeding and restriction of the number that may graze in an area in a specified period will make the cultivator and the grazier exercise discrimination to eliminate useless cattle and keep only a small number of the better strains. No doubt they will consider

it an encroachment on their privilege to graze without let or hindrance; in course of time they will realize that the restrictions were for their benefit. Data should be collected to assess the area of the grazing lands and the incidence that they can bear. Keeping in view the forementioned objects, ways and means should be devised to regulate grazing and improve the pasturage. Though it is an elaborate job demanding detailed investigation, it is hoped the forest departments will rise to the occasion and the governments will provide necessary facilities. The current procedure of entrusting the regulation of grazing to working plan officer is unsatisfactory, because he has to remain within the framework of the rules and regulations and cannot make far-reaching recommendations for the improvement of the cattle or the grazing grounds; and naturally considers it as an item of subsidiary importance as far as he is concerned.

Finally, without being unduly pessimistic, one may sound a note of scepticism. The number of the reconstruction committees is too big and the governments having scores of problems to tackle will be inclined to classify the recommendations of the experts according to the importance of the branch they relate to. What position is to be allotted to the forest problems? The status given to forestry at Hot Springs in the Interim Commission appointed to make proposals for a permanent international organisation for food and agriculture, despite the apologetic explanation of the forestry delegates, will not be viewed with equanimity by the forest services. Will forestry continue to be treated as an unavoidable adjunct to agriculture or will a more important and independent place be assigned to it? At any rate, in India, where the forests are to play a prominent part in the industrial and agricultural economy of the country, they are entitled to a more honourable role.

And what are the chances of the schemes to be implemented? Are they to remain as pious hopes and lofty ideals only to be cherished or will they be realized in practice? In the existing forest policies, too, the conservation of the forests for maintaining water supplies and the satisfaction of the requirements of the population, are accepted as the basic principles of forest management. Forests are supposed to be worked for revenue after the fulfilment of the above fundamentals. These highlights of the policy are reproduced in all the working plans. And yet we know, though we may not say in so many words, that even *bona fide* domestic needs of the villager residing near the forests are not fully met, and he has to do a bit of pilfering; and, for all intents and purposes, income continues to be regarded as the supreme object of management. Let us hope that this outlook, for which the Government and not the Forest Department is responsible, will give place to a more rational one, so that foresters may work unhampered for the improvement of the forest wealth and amelioration of the peasant's lot.

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STORAGE OF SEED OF PROSOPIS SPECIES

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In the *Indian Forester* for January, 1945, p. 19, the forest entomologist suggested that preliminary tests should be carried out to determine the effect of naphthalene and para-dichlorbenzine on the germination of seeds of *Prosopis* spp. as it is possible that these two chemicals may be of use in dealing with the insect pests of the seeds of these species.

In consequence the silviculturist in conjunction with the entomologist has carried out some preliminary experiments.

Seeds of *P. juilflora* (Australian variety) and *P. glandulosa* (tree form) of the 1944 seed crop from the Punjab, the germination of which was described in the January issue, were carefully picked over and samples of good, insect-free seeds were selected. This selection was done by eye and was not perfect as a few insects emerged during the storage and treatment.

The seeds were divided into four sets and treated as follows:

A—Untreated control, stored in an open bottle.

B—Untreated control stored in an airtight bottle. (This treatment was necessary as it is only possible to do treatments C and D in airtight bottles and this method of storage alone might cause deterioration of the seed.)

C—Seed stored in an airtight bottle with para-dichlorbenzine at the normal rate of 1 gm. per litre.

D—Seed stored in an air tight bottle with naphthalene at the normal rate of 1 gm. per litre.

The storage was for two months as this is about the time the seed is likely to have to be stored between collection and sowing. At the end of this period (January 14th) the seed was sown in germinating trays. It is to be noted that the middle of January is not a favourable time climatically to sow seed and consequently results were expected to be poor.

Germination started in 10 to 14 days and continued for roughly three months, giving the following results:

GERMINATION PERCENTAGE

	P. juliflora.	*P. glandulosa*
A—Untreated control, open.	61	73
B—Untreated control —airtight bottle	39	52
C—Paradichlorbenzine	40	53
D—Naphthalene. ..	31	72

Indication.—It thus appears that storage in a closed bottle for a period of two months causes a reduction in the germinative capacity of the seed of both species but that normal doses of the chemicals (parachlorbenzine 1 gm. per litre and naphthalene 1 gm. per litre) have no effects in impairing the germinative capacity of either species.

Further experiment.—To continue the tests a little further and as sufficient of the *P. glandulosa* seed still remained, the seed which had already been stored and treated as described above was tested further.

It was again treated and stored for a further month but with very heavy overdoses of the chemicals (10 to 50 times the normal dose was given). On testing, the following results were obtained:

GERMINATION PERCENTAGE

(HEAVY OVERDOSE OF CHEMICAL)

	P. glandulosa
A—Untreated control—open ..	66
B—Untreated control—airtight bottle	61
C—Paradichlorbenzine ..	37
D—Naphthalene ..	64

These results read in conjunction with those already given indicate that even a very heavy overdose of the chemicals has little or no effect on the germinative capacity of *P. glandulosa* and they are therefore quite safe to use.

It is to be noted that, taking all the results together, it is doubtful if storage in an airtight bottle causes a significant reduction in the germination percentage of these two species.

As already pointed out in the previous article, paradichlorbenzine and naphthalene are both crystalline, harmless to man, and easy to use whereas the commoner fumigants, such as carbon bisulphide and hydrocyanic acid, are dangerous poisons and require careful handling.

The forest entomologist is later giving us a detailed account of the effect of paradichlorbenzine and naphthalene on the insect pests that we have found in these two species and which he is separately testing.

DEVELOPMENT OF FORESTS AND WOODLANDS IN SIND—II.*

By J. Petty, M.C., O.B.E., I.F.S.

(*Conservator of Forests*)

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LIST OF TREES, SHRUBS, ETC., MENTIONED

1.	*Arjan*	.. *Terminalia arjuna.*
2.	*Babul*	.. *Acacia arabica.*
3.	*Bahan*	.. *Populus euphratica.*
4.	*Gidamri*	.. *Tamarindus indica.*
5.	*Gugul*	.. *Balsamodendron mukul.*
6.	*Jaman*	.. *Eugenia jambolana.*
7.	*Kandi*	.. *Prosopis spcigera.*
8.	*Kumbhat*	.. *Acacia senegal.*
9.	*Lai*	.. *Tamarix spp.*
10.	*Lohrio*	.. *Tecoma undulata.*
11.	Mesquite	.. *Prosopis juliflora.*
12.	Mulberry	.. *Morus alba.*
13.	*Nim*	.. *Azadirachta indica.*
14.	*Pakar*	.. *Ficua infectoria.*
15.	*Rain*	.. *Pithecolobium saman.*
16.	*Siris*	.. *Albizzia lebbek.*
17.	*Tali*	.. *Dalbergia sissoo.*
18.	Olive	.. *Olea ferruginca.*

* Concluded from *Indian Forester*, Vol. LXXI, No. 7, dated July 1945.

LIST OF LOCAL WORDS USED

1.	*Abkalani*	.. River floods.
2.	*Dhandh*	.. Water left after floods, a marsh ; a miniature lake.
3.	*Nullah*	.. Mountain stream flowing during rains.
4.	*Zamindar*	.. A landholder.
5.	*Jagirdar*	.. A landholder with special rights.
6.	*Huri*	.. A *zamindari* plantation.
7.	*Kacha*	.. Temporary.
8.	*Paka*	.. Permanent.
9.	*Taluka*	.. Subdivision of a revenue district.
10.	*Mukhtiarkar*	.. Revenue officer in charge of a *taluka*.
11.	*Mahal*	.. Subdivision of a revenue district somewhat smaller than a *taluka*.
12.	*Mahalkari*	.. Revenue officer in charge of a *mahal*.
13.	*Hur*	.. A fanatic follower of Pir Pagaro.
14.	*Maldar*	.. Grazier.
15.	*Kasi*	.. Small irrigation channel.
16.	*Hari*	.. Cultivator.
17.	*Tapedar*	.. Minor revenue official.

[*When cubic-foot figures are given they are for "stacked" c.ft. of which* 1,000 *(a stack) average* 250 *mds. in weight and will yield about* 80 *mds. of charcoal.*]

PART III

Recommendations

(*a*) *Rural Areas*

38. The main industry in Sind is agriculture and its prosperity is of cardinal importance. For a balanced rural economy adequate supplies of free or very cheap and easily accessible wood are essential.

In other provinces, a *laissez faire* attitude was adopted when development was taking place and, as a result, in most of rural India, there is no wood for fuel whilst agricultural implements and small timber for housing are costly. Cowdung, instead of fertilizing the land, is consumed as fuel and this is one of the major causes for the low crop outturn from Indian farming. Sind has started to follow this downward path but if action is taken immediately a sound position can soon be established ; but if action is not taken all hopes of any successful rural reconstruction must be abandoned as wood (in large quantities) is essential to develop the countryside.

39. As mentioned in para. 21, Government are now considering a proposal from the Forest Department that *jagirdars* and *zamindars* owning 100 acres or more must be compelled or persuaded (by giving assessment concessions etc.), to keep part of the estate under tree growth to ensure enough wood for all purposes for themselves and their *haris*.

Cultivators everywhere in the world are conservative and are unwilling to change farming methods until someone else has proved that change is advantageous. Fortunately, many expert cultivators in Sind especially around Hyderabad—have made it a regular part of their farming system to grow *huris* (para. 5). So it will be no hardship and there will be no loss of income if all *zamindars* in Sind have to follow a similar practice and also raise carefully-sited windbreaks, grow trees along all *kasis*, tracks, etc. etc.

According to information received from the Director of Agriculture, the larger estates cover rather more than 50 per cent. of the privately-owned lands so this reform will mean supplies of wood are assured for more than half the rural areas.

40. The smaller landowners must also be encouraged to raise trees along watercourses and tracks, near their huts, etc., but some other sources of wood must also be found for them.

The P. W. D. canalbanks and borrowpits, etc., can be fully planted with trees and this estate will then provide some easily-accessible wood. Similarly, if all public roads and tracks are lined with trees, wood from thinnings, etc., will be available for the rural areas. These two sources should meet much of the demand.

41. Attempts must also be made to develop some of the wastelands though much of this land is of poor quality, highlying and cannot be irrigated. If grazing is regulated, however, and proper protection is ensured, scrub forests can be maintained which will be useful as grazing grounds and sources of fuel.

Before any plans can be made the location of these wastelands must be shown on maps. Photo-zinco copies of *taluka* soil classification maps are now being printed and when these are available the larger areas of wastelands can be shown on them. Forest and Rural Reconstruction Department officials can then visit these areas to examine the possibilities of raising village plantation, etc. etc., and prepare definite plans for making them productive.

42. For example, the land between the Haleji *dhandh*, the North-Western Railway, Gharo and the provincial roads should be declared reserved forest and endeavours be

made to raise plantations of trees using surplus water from the *kalri* which is normally available during the *abkalani*. Apart from these operations yielding valuable experience concerning afforestation of poor lands, they would fix the ground cover of vegetation and prevent drifting sand blowing into the Haleji lake or damaging the waterworks.

43. In future wherever large blocks of land are being developed (*e.g.*, Makhi *dhand*, land commanded by the new barrages, etc.), some areas must be set aside near each township and hamlet for woodlands. These woods should preferably be in charge of the leading *zamindar* to ensure proper protection but the planning of the plantations, technical advice, etc., will have to be provided by the Forest Department.

44. The preliminary works in connection with this effort can easily be completed within five years and, if all these proposals are carried out—and none are impracticable—a great advance towards a balanced rural economy will have been made.

(*b*) *The Desert*

45. The desert in the east of the province maintains large herds of fine cattle and, with the help of cultivation on rainwater, sustains a small population. Until recently, however, when a desert farm experimental station was opened near Mithi, nothing has been done to develop or even preserve the vegetation. Enquiries made from the local "oldest inhabitant," etc., indicate that there are now far fewer trees than there used to be, whilst along the fringe of the desert adjoining the irrigated lands and also around all centres of population there is obviously severe overgrazing and near Umerkot there are signs that the desert is beginning to encroach. The effect of erosion by wind or weather and desert encroachment are not easily recognisable especially in the beginning when the process is slow; but if unchecked the damage done is colossal. Lakhs of acres of fertile land in the "dust bowl" in the United States of America have been ruined by wind erosion and if the vegetation ground cover in the Sind desert is allowed to disappear wind erosion will soon make these areas totally unproductive and may severely damage or ruin many fertile lands elsewhere. It has been suggested that because the prevailing wind is south-west the Indus valley will not suffer if the desert sands are eroded; but nature does not always behave as expected and, of course, such a petty provincial attitude is deplorable.

46. Little is known of the rate of growth of the desert flora, how many acres are required to maintain one animal, etc. etc., and research is urgently needed, but this will take years. Meanwhile, to ensure that some parts of the desert are properly managed, it is proposed that areas as under should be declared reserved forests:

(*a*) A strip of the desert between 5—10 miles wide along the fringe where it impinges on the irrigated cultivation. This forest strip would start north of Sanghar and run *via* Khipro, Umerkot, Nabisar and Naokot to Rahemki Bazaar.

(*b*) A similar strip along the Sind-Cutch border from Rahemki Bazaar *via* Adhegam to Berano.

(*c*) Areas of 10 miles radius around all the main centres of population in the desert.

For these forests working plans will be made which will ensure systematic closure to grazing for long periods to allow natural and artificial reproduction, that the number of cattle allowed to graze is not above the fodder capacity of the land and that cutting, hacking and lopping of the existing tree growth is curtailed.

Everything possible must be done to persuade the people to work with and not against the Forest Department. A "velvet-glove" policy is essential. Government must spend and not expect to make money out of these forests because such expenditure, more than anything else, will help the local people to realise that the restrictions are being enforced for their benefit and not for the benefit of Government. In addition, after the war, when wire and iron stakes are more easily obtainable, small areas near most villages and hamlets should be completely enclosed so that from examples the people can see how closure increases the vegetation. The local headman should be given the privilege of cutting grass, etc., in these enclosures in exchange for his co-operation. Iron stakes are essential because the plots will have to be maintained for many years and white ant and other pests will destroy wooden posts.

Two or three experimental stations on similar lines but on a smaller scale to the desert farm at Mithi must be established for research

purposes, not only to study reproduction and rate of growth of the desert flora, the propagation of the more valuable fodder plants or dwarf trees such as *gugul* (from which gum mukhal is obtained), etc., but also the cutting and storage of fodder grasses because in this area of uncertain rainfall some scheme similar to famine relief grass storage as carried out in the Bombay Province is necessary to mitigate the disasters that always occur when the rains fail.

47. A divisional forest officer, Thar Parkar (with a staff of range forest officers, surveyors, etc.), must be appointed as soon as possible to study the whole question in conjunction with the revenue officers and put up more detailed schemes. It should be possible to complete the preliminary investigation and the settlement within about three years.

48. The population is increasing along the fringe of the desert as more and more land is being cleared for cultivation. Unless grazing grounds are available and cheap and easily accessible wood can be obtained the desert vegetation will be used. It is proposed, therefore, that some blocks of reserved forest should be established between the desert and the cultivated area to provide wood for local industry such as brickmaking and meet the requirements of the growing population centres in the Thar Parkar and Nawabshah districts.

49. Units of 5,000 –10,000 acres are administratively the most convenient but there are other matters which have to be considered. The Makhi *dhandh* area could comparatively easily be converted into a regular forest but it is believed that Government wish to clear this area in order that there shall be no refuge for the Hurs. However, from information supplied by the Revenue Officer, Lloyd Barrage, it appears that, in addition to the Makhi area, there is much land in Sanghar *taluka*, still Government-owned, and from this it ought to be possible to obtain between 10,000—20,000 acres for forest. If for security reasons it is necessary the forests could be in small blocks of about 500 acres so that they would not make good hiding places.

In Khipro *taluka* 10,000—15,000 acres of land are still available much of which might be afforested.

In Umerkot *taluka*, not more than 5,000 acres can probably be found but this will be sufficient.

Finally in the Fuleli Escape and Dhoro Puran areas there are approximately 10,000 acres of quite well-wooded land which could make excellent forest and, if the railway to connect with Bombay is made by extension from Badin, will be very valuable.

In all it should be possible to afforest about 40,000 acres near the desert. Irrigation will be rather difficult but the possibilities of lifting water on a large scale from the Nara, etc., have not yet been investigated and even if this is too costly, once the tree growth is established it will grow given protection.

Completion of survey works and preparation of definite schemes by the Divisional Forest Officer, Thar Parkar, should not take more than 2-3 years, settlement might take another year or so but organised forestry should be easily possible within five years.

(c) The Hill Areas

50. From a distant prospect the hills seem to be devoid of any vegetation but a closer inspection reveals a varied flora which includes a number of grasses, shrubs and plants, together with a few stunted trees, some of which have fodder value. The depressions and *nullahs* contain many more trees and shrubs and the growth is comparatively good. In all there is sufficient vegetation to support a fairly large animal population—particularly during the rainy season—but not sufficient to stop erosion and floods. At times the floods do immense damage as in 1944 when the Gaj river in spate broke through all the protective stonework and bunds, ruined large areas of crops and damaged much fertile land. Such floods cost the province many lakhs of rupees but nothing has ever been done to try and stop these floods at their source which is the river catchment area.

51. In the Punjab reafforestation of the foothills has been in progress for some years and already striking results have been obtained. The Punjab Government would probably allow one of their anti-erosion experts to visit Sind to give advice on the subject. It must be realised, however, that the rainfall here is so comparatively small that afforestation will be an extremely slow process but if Baluchistan will co-operate with Sind in this work, which should be concentrated, to begin with, on one river system—for instance, the Gaj river—much experience will be gained and almost certain valuable results.

52. Apart from contour-trenching, contour-bunding, gully-plugging, etc., much might be achieved if Nature is given a chance. With ever-increasing herds of animals, particularly goats and sheep wandering over the hills, the vegetation has no chance to flourish or increase. A few selected areas should, therefore, be declared reserved forest and working plans be made to ensure results as mentioned in para 46 in connection with desert development.

53. A most obvious area for this is the Dumlotte catchment from which Karachi obtains much of its water-supply. If the tree growth and other vegetation could be considerably augmented the rainwater would be absorbed instead of running off the hills and a much larger volume of water would reach the underground channels instead of flowing into the sea along the Malir river-bed.

Parts of the catchment area are privately owned and there may be "rights" and privileges.

The owners of such lands or "rights" must be compensated or promised the bulk of the revenue which will result from proper management. As a first step, whilst surveys are being made, the local revenue officials might be able to persuade the local people to close to grazing one valley or one side of a valley. Many wired enclosures must be established in this area also (as suggested for the desert) to show closure effects and for experimental purposes.

54. Another area obviously suitable for development is the plateau in the vicinity of Thano Bula Khan and the area between that village and Kotri. The co-operation of the local population here, as elsewhere in the desert and hills, will be required and probably a forest officer would be the best person to persuade the people to help. If he also had some powers it would be of great assistance and it is recommended, therefore, that the Kohistan Mahal (where there is comparatively little crime) should be put in charge of a range forest officer (forest officers hold similar charges in parts of the Bombay Province). This officer could manage a small experimental station at Thano Bula Khan and after a year or two could report on the possibilities of afforestation, closure, etc. etc.

55. A third area suitable for experiment which might be declared forest is the land at the foot of the hills between the Gaj bungalow and the Manchar lake. There is some tree growth in the *nullah* beds and, with proper management, the area would undoubtedly maintain for more *lai* and other trees. Wood is badly needed in the small townships in the Dadu and Larkana districts situated at some distance from the river and these new forests might help to meet requirements.

56. A sub-divisional forest officer, with a small staff should be appointed as soon as possible to start surveys, propaganda, etc. The staff to carry out larger operations can gradually be built up.

57. More definite and detailed proposals cannot be given at present as so little is known about what can be achieved in areas having a rainfall of seven inches or so. But if the above suggestions for the hills and desert are adopted, a mass of extremely valuable data will be available within a few years and Government can then decide on what scale further operations shall be carried out.

Whatever decisions are reached in future, if Sind is to be fully developed the almost complete neglect of 30,000 square miles of territory must certainly cease.

(*d*) *The Forest*

58. In para. 37 it was estimated that a threefold expansion of forest production to 55–60 million c.ft. annually was necessary within the next 2-3 decades. How this can be achieved will now be considered.

59. The "riverain" forest estate of nearly 800 square miles normally produces about 16 million c.ft. annually. A few years ago, however, Mr. D. B. Sothers, C.I.E., I.F.S., made a careful examination of data available and reached the conclusion that, when the new Punjab storage schemes and the two additional barrages in Sind are functioning, the flood levels will be lowered to such an extent that the forest production will not exceed 5-6 million c.ft. annually. Erosion and accretion will, however, continue and eroded land will be thrown up at levels which will normally be flooded so the useful part of the estate will gradually increase in area and production will rise; but this increase will be slow.

In the past little has been done to develop these riverain forests but if the system of management is revised (this will be discussed

under working plans below), some capital is spent on draining and cutting channels to assist irrigation, more pumping sets to lift water are established, etc. etc., it ought to be possible to augment production and it is hoped, therefore, that production will never fall below *nine million c.ft annually.*

60. Excluding the forests it is believed that the remaining land between the river protection bunds is about 1,600 square miles of which about half is probably Government-owned. The Government lands are scattered amongst the privately-owned areas but probably by exchange, purchase, etc., sufficiently large areas to be administratively convenient could gradually be obtained, to increase the forest estate by 700—800 square miles.

Government, at present, make little revenue from their riverain property because revenue officials have no time to visit these lands, recover correct assessment, etc. If the whole area was put in charge of the Forest Department (forest officers being made *ex officio* revenue officials) more attention would be paid to the collection of Government dues and the selection of areas suitable for afforestation will be facilitated. Preliminary work such as mapping of areas proposed for forests could, probably, be completed in 2-3 years and the settlement be finished within five years. Thereafter organisation and sowing up the estate would soon be completed and a yield of *nine million c.ft. annually* should be possible by about 1960. The settlement of this area could be combined with the fixation of the existing forest boundaries, work on which had to be suspended in 1942.

61. The inland forests cover about $2\frac{1}{2}$ lakh acres and are gradually being converted into irrigated plantations. It is estimated that it should be possible to convert in all 1,60,000–1,90,000 acres when the new barrages are functioning but for various reasons such as insufficient water available in the Dadu canal system, high-lying sandy lands, etc. etc., it is unlikely the remaining area of perhaps 75,000 acres can be developed. This area, therefore, will continue much as at present and produce a meagre outturn. Twelve to 15 c.ft. n acre a year was the past production and robably this cannot be increased to more han 20 c.ft. These 75,000 acres of inland rests cannot be expected to yield more than *million c.ft. annually.*

62. No irrigated plantation in Sind has yet reached maturity so exact yield figures are not available. It is estimated, from data already collected, however, that these plantations will yield at least 100 c.ft. an acre a year. In due course, therefore, if about 1,75,000 acres of the existing inland forests are converted, the production should be $17\frac{1}{2}$ *million c.ft. annually.*

63. In para. 49 the establishment of 40,000 acres of forest near the desert is proposed. The water supply to irrigate these areas will be partly unassured and in consequence the rate of tree growth will not be great. An average outturn of about 40 c.ft. an acre a year from this estate ought to be possible which would mean an annual yield of about $1\frac{1}{2}$ *million c.ft.*

64. The P. W. D. estate will produce substantial quantities of wood in due course (mostly in the form of timber) and it appears, therefore, if the above outturn estimates are correct, about 1,50,000 acres of land, which will be made productive when the new barrages are completed, will have to be reserved for irrigated plantations to yield 15 *million c.ft. annually.* These new forests should preferably be in belts or strips along the canals and minors so that the trees can obtain some of the water they require by percolation. Another advantage of these strips will be that forests will be well-distributed throughout the rural areas and can thus help to meet the local fuel demands.

65. If the proposals made in paras. 59 to 64 are carried out, ample supplies of wood for Sind should be assured and with the establishment of the privately-owned woodlands proposed in para. 39 the area of forest in Sind should total approximately 20 per cent. of the cultivable land which is about the minimum figure for a province recommended by Sir Herbert Howard, Inspector-General of Forests to the Government of India.

66. In order that more intensive working of the estate can be carried out working plans will have to be entirely revised. At present the "cuts" are regulated by area and approximately one-thirtieth of the estate is cleared annually. Because of the vagaries of the *abkalani*, however, the annual volume increment varies considerably from period to period and the fellings, therefore, should be regulated by volume and not by area.

Every five years the working plans staff should fully enumerate the growing stock of a division (except the seedlings and saplings,—one to four years old, which will form a reserve) and from these figures, the totals at the last stock-taking and details of output during the previous five-year period it should be possible to fix a conservative outturn figure corresponding to the anticipated volume increment of the forest for the next five years. Each year approximately one-fifth of this figure will be cut. Essential fellings such as erosion strips, burnt-wood areas, silvicultural thinnings, etc., will first be marked and the balance output required will be made up by clear-felling of coupes.

67. There should be no fixed rotation. The forests are essentially fuel forests and the size of billets required by the market for either firewood or charcoal must be the guide to the size of trees to be grown. Probably the billets wanted do not exceed 18 in. to 24 in. in girth and in the best riverain areas a *babul* tree will grow to this size in 8–10 years; though where the irrigation and other conditions are not so good it may take 15 years or more. Perhaps one-tenth or so of every *babul* "cut" might be reserved to produce timber otherwise all other *babul* woods should be felled as soon as they reach the 18 in.—24 in. girth limits.

Kandi which is slower growing (also harder to cut) should probably be considered mature on reaching about 18 inches in girth which will take 12—20 years, as *kandi* is useless as a timber no part of any cut of this species should be reserved for timber production.

The size of *lai* required for firewood (this species does not make good charcoal) probably does not exceed 12 in. to 18 in. girth which should be reached in 7—10 years.

Bahan (a poor fuel) should be grown entirely for timber and silvicultural treatment should aim at timber production. A tree of about six ft. in girth can be grown in about 20—25 years.

The working plans staff will, of course, make careful investigation of sizes of fuelwood required, etc., before laying down the prescription of the new plans.

68. Agri-silvicultural methods of re-afforestation should be adopted wherever possible and become part of the normal Sind forestry system as they yield a greater outturn from the land and far higher financial returns without any serious sacrifice of wood production.

69. In para. 59 a brief mention was made about development of the riverain forests by drainage channels, etc. Schemes for each block of forest should be drawn up during the next year or so. The working plans staff can review these plans and lay down which schemes shall be carried out during the ensuing five year period.

70. Working schemes for each irrigated plantation will also have to be prepared. These plantations are only in their infancy and there is still much to be learnt. Amongst the problems which require research are:

(*a*) The minimum quantity of water which will yield an outturn of 100 c.ft. of wood an acre a year.

(*b*) The best irrigation methods, *i.e.*, what should be the width and depth of the trenches and should they be dug alongside the tree lines or midway between the lines?

(*c*) What modifications of technique are necessary to avoid "wilt" disease which has appeared on a small scale in Khathar—Khatro I. P. areas.

(*d*) What better fodder grasses such as giant star grass, etc., can be established without damage to the soil fertility.

(*e*) What timber trees can be produced, etc. etc.

71. The irrigated plantations near Miani and Khathar are suitable for experimental purposes on a forest scale whilst the gardens and nurseries near the Miani bungalow should be expanded. Around that building 100 plots of an acre each should be laid out and experiments with some twenty or more exotic timber trees be made. Different intensities of irrigation should be carried out so that their effect on the rate of growth, etc., can be discovered.

Of the exotics, mulberry has already proved a success and one species of willow i growing well. After the war is over, son cuttings of the true "Cricket bat" willo should be imported from England as if tl tree can be grown in Sind, as appears possib the province (with mulberry and *bahan*) v be producing all the raw material required

a sports goods industry. Amongst other exotics particular attention should be paid to bamboos which would prove most useful for hutting and *Acacia mollisema* and *Acacia decurens* which yield the valuable "wattle bark" now being imported in vast quantities from South Africa for tanning work.

72. In every irrigated plantation a small area should be laid out as an orchard.

73. The irrigated plantation areas should prove suitable for rural reconstruction settlements. As agri-silviculture will always be employed, about one-third of the area will be growing agricultural crops which will provide plenty of seasonal work whilst at other times of the year ordinary forest operations will give employment. It may be necessary at first for the Forest Department to act as a *zamindar* and take a share of the crop in payment of lease money but this and many other matters will have to be examined when detailed schemes are being prepared. These colonies should eventually prove useful recruiting grounds for the subordinate forest staff.

74. In para. 28 it is stated that schemes for irrigated plantations covering nearly 40,000 acres have now been sanctioned by Government and working has started or is just starting. During the next five years it should be possible to increase this area to perhaps 75,000 acres if the P. W. D. will continue to give their valuable help as heretofore. Forests in which irrigated plantations might be established or expanded in the near future are :

Gharko, Penah-Huderani, Mulchand and Hazari in the Karachi Division.

Gari Yassin, Kot Sultan, Muhromari and some of the smaller forests in the Shikarpur Division.

Ghotki and adjacent forests and Adalpur in the Sukkur Division.

Little further development is possible in other divisions as existing schemes cover all the available forests or will utilize all the available water.

Any further major conversions of inland forests into irrigated plantations will have to wait until the new barrages are functioning.

(e) Miscellaneous

75. The complete afforestation of the P. W. D. estate must be carried out. Trees on the canal banks should be grown for timber and in the borrowpits, etc., for fuel. In the United Provinces the Forest Department has taken over the canal plantations with beneficial results. At first the Forest Department merely planned and the P. W. D. establishment attempted to follow the advice given; but results of this dual management were not very satisfactory and eventually the Forest Department took complete charge. The division of the revenue resulting from these operations was settled after much discussion. After all expenses have been paid, the P. W. D. are credited with two-thirds and the Forest Department with the remainder of the surplus.

At present the Forest Department has not sufficient trained staff to take over the tree production on the whole of the P. W. D. estate but it should be possible within 3-4 years for working schemes to be drafted by forest officers for each canal system which the P. W. D. (with a slight increase of subordinate staff) can follow. Eventually these areas should be declared reserved forest and be managed by the Forest Department.

76. Roadside avenues throughout the province must be established as soon as possible. On the main roads the working scheme outlined in para. 23 should be followed; on the minor roads *babul* should be raised. Whenever new roads or the improvement of old tracks are being planned the provision of ditches for irrigating the roadside trees should be included in the plans. Even where canal irrigation is not available much can be done. For instance on the Karachi-Kotri highway, except in the vicinity of Tatta, there is no canal water; but from Karachi to Gharo the Haleji waters might be tapped during the *abkalani* when surplus water is available and elsewhere deep ditches on either side of the road will probably collect enough rainwater to sustain drought-resisting trees such as the mesquite, especially if pits are dug in the ditches wherever the trees are put in. Eventually the Forest Department should manage all the trees along the roads whether the latter are in charge of the P. W. D., local boards or municipalities to ensure proper silvicultural treatment, protection, etc., and these road areas should be declared reserved or protected forest.

If energetic action is taken it should be possible to have most of the existing road system planted up within five years or so by

which time the Forest Department staff should have expanded and be able to take over roadside avenue maintenance.

77. Around many resthouses in Sind there are large compounds and water for irrigation is usually available; but little is done to properly use this land and water. Fruit trees are frequently planted when the bungalow is built but owing to the ignorance of the *malis* and general lack of interest they seldom have proper treatment and are only partially productive. Considerable expenditure is incurred on these gardens but all there is to show for the money (in most compounds) is a few trees, some neat hedges and perhaps some not particularly attractive flowers.

These lands could easily become of value without losing any æsthetic effect if part of the area were made into nurseries for the raising of the trees required for orchards and for the roadside avenues.

Two or three horticulturists should be appointed as soon as possible who should tour regularly. They should revise the layout of the gardens where necessary and draw up definite schemes for their development. Instructions for the tending of the trees, vegetables, flowers, etc., should be written down and one copy be given to the local sub-divisional officer and another kept in the bungalow available for visiting officials. Garden accounts should be maintained and regularly inspected, and within a very short time, these small areas could be made productive.

78. The importance of parks in towns and *green belts* around urban areas is well-known and Government should request local authorities to earmark areas for these purposes before land values become too great.

79. In order to stimulate interest in tree growing, "tree-day," which has been observed for the past two years, should continue. As yet there has not been sufficient propaganda to make the day a real success but if efforts are continued especially in the schools—this annual event may become a valuable means of making the Sind public "tree-conscious."

80. Some lectures on forestry and the value of tree growth should be included in the syllabus at the Agricultural College at Sakrand. These could be delivered by the Divisional Forest Officer, Nawabshah, and he and the range forest officers at Sakrand could show the students forest works in the nearby Pai and Mari forests. Similarly, the *tapedars* training course should include a little general forestry. The Divisional Forest Officer, Hyderabad, could give the lectures and Miani and other forests are within easy reach for practical demonstrations.

81. The Inspector-General of Forests to the Government of India is always prepared to visit provinces to give advice, etc., if invited. Such visits are of great value not only to the forest officials but also to Government as a printed report of the observations made during the tour is always sent after the visit. It is suggested that the Inspector-General should be invited to visit Sind at regular three-year intervals.

82. Agriculture and forestry are allied subjects and it would, therefore, be advantageous if these portfolios were held by the same minister.

(*f*) *Policy*

83. If all or most of the above proposals are to be carried out it is essential that a forest and woodlands policy be laid down by Government and endorsed by the Legislative Assembly in order to ensure continuity of operations. If this is not done, works may be suspended or curtailed by orders from other departments—particularly the Finance Department. This has happened in the past in India and may happen again unless the Legislative Assembly insist on the carrying out of the planned development of the province.

The Government of India forest policy was defined in Circular No. 22-F., Government of India, dated 19th October, 1894, and is contained in the Forest Code, 7th edition, Appendix V.*

Briefly the outstanding principles of this policy are:

(*a*) That first and foremost the preservation of the climatic and physical conditions of the country comes before everything else.

(*b*) That the preservation of the minimum amount of forest necessary for the general well-being of the country is second only to, (*a*) above. But

* Reproduced also in the *Indian Forester*, Vol. XX, No. 11, page 414, dated November, 1894.

provided the above two conditions are fulfilled, then:

(c) Cultivation comes before forestry;

(d) The satisfaction of the wants of the local population free or at non-competitive rates comes before revenue; and

(e) After all the above are satisfied, realization of revenue to the greatest possible extent is permitted.

These principles might form the nucleus of a Sind forest policy to which some of the detailed recommendations given in paras. 38–82 above should be added.

Possibly the appointment of a small committee of members of the Legislative Assembly, *zamindars*, etc., to report within three months on a forest and woodlands policy would be a useful preliminary step.

PART IV

STAFF, ETC.

84. The gazetted staff of the Forest Department is now 11, as under:

1 Conservator of Forests.

6 Territorial Divisional Forest Officers.

1 Working Plan Divisional Forest Officer.

1 Silvicultural Divisional Forest Officer.

1 Utilization Divisional Forest Officer.

1 Sub-Divisional Forest Officer.

It is estimated that the additional staff required as soon as possible to start the works recommended above is 11:

1 Conservator of Forest Development.

1 Territorial Divisional Forest Officer (the existing Sukkur and Shikarpur divisions must be divided into three divisional charges).

1 Thar Parkar Divisional Forest Officer.

8 Sub-Divisional Forest Officers (one for each of the territorial and Thar Parkar Divisions).

The senior conservator of forests will act as adviser to Government and also control all the operations of the territorial divisions. The development conservator of forests will control the work of the divisional forest officers for working plans, silviculture, utilization and Thar Parkar and supervise the anti-erosion operations in the hills.

The sub-divisional forest officers attached to each territorial division will be chiefly occupied during the next few years in collecting data for plans for the expansion and development of the riverain forest areas, preparing working schemes for the afforestation of the P. W. D. and other Government-owned estates and in assisting to raise roadside avenues throughout the province.

If the developments proposed are to be carried out, the first step will be the immediate appointment of a conservator of forests, development, who will prepare detailed schemes and gradually accumulate the staff required for their executive. It is utterly impossible for one conservator to administer the department and also make the careful inspections necessary and go into details in connection with these developments.

85. Including replacement of officers (due to retirements, etc.), Sind must recruit some 12 gazetted officers by about 1951-52. At present under training at Dehra Dun there is one officer candidate and during the next five years it is hoped Sind will be allotted one seat yearly at the superior service training course. Six Officers, therefore, can probably be obtained by direct Dehra Dun-trained recruitment; the balance will have to be found by promotion of range forest officers from the existing cadre.

86. Between 1950 and 1960 a further expansion of gazetted staff will be required to cope with the increased areas under irrigated plantations and other works. One additional conservator and eight or 10 divisional forest officers will certainly be the minimum number necessary and, of course, provision will also have to be made for normal wastage replacement.

Probably the work of the department will have expanded to such an extent by about 1950 that a chief conservator will be necessary to act as adviser to Government, co-ordinate Forest Department activities with that of the other departments concerned and draw up plans for further developments.

87. The sanctioned cadre of the range forest officers is 26. There are now 19 trained

rangers serving, one surveyor and two foresters acting as rangers whilst two candidates are under training at the Rangers College at Dehra Dun.

88. The ranger cadre will have to be doubled as soon as possible and a further steady increase will be necessary up to about 1960. Including wastage due to promotions, etc., it is estimated Sind will require about 35 new rangers within the next few years. It is hoped that Sind will be allotted four seats yearly at the Ranger College and, within six years, therefore, 24 direct Dehra Dun-trained recruits will be available for service. The remaining number required will have to be obtained by promotion.

89. Government approved recently of the creation of some new posts of deputy rangers. These will be filled by men who have similar qualifications to those required for admission to the Rangers Training College but for whom vacancies cannot be found. These men will be posted to serve under senior and experienced rangers and will gradually learn forestry business so that in a few years they may be capable of managing a range and be promoted to the ranger cadre.

90. In the past the subordinate staff has been recruited largely from the *maldars* and villagers living near the forests and most of these men have been illiterate. They have never had any proper training but, gradually, by experience, learnt their work of protection and simple silviculture. Operations are now becoming more complicated with the introduction of agri-silviculture, etc., and literate men must be recruited and given some proper training.

In the past a starting pay of Rs. 14 or 15 for a forest guard was not unreasonable, but if a better type of man is to be obtained minimum rates of pay will have to be raised. At present a coolie working half a month can make more than a forest guard receives for a whole month and, in consequence, only the lazy and feckless are coming forward to fill guard vacancies and the quality of the staff is deteriorating. As some 300—400 new recruits will be required in the next few years the question of pay and prospects should have attention in the near future.

91. To train the subordinate staff a forestry training course must be started as soon as possible. Probably three-four months training will be ample and the course can be conducted by a range forest officer with perhaps a few additional lectures by specialists such as the divisional forest officer, silviculture. A suitable place for the course would be either Sakrand, where there are good forests in the vicinity (including Pai which is being converted into an irrigated plantation) or near Miani where there are experimental gardens, etc. Perhaps Sakrand would be the most suitable as the officer at the King George V Agricultural College might be able to help in general training by giving simple talks about agriculture and its development. It should be possible for the development conservator of forests to put up a detailed scheme for subordinate training within a year or so.

The training course in horticulture at Mirpurkhas, where several forest guards are now working, should be continued because the forest area under orchards will rapidly increase as irrigated plantations are created.

92. The clerical staff of the department will have to expand as rapidly as the field staff. At present, as the prospects in this department are much worse than in many other Government departments, only the poorest type of clerk wishes to join and even these recruits, during their first few years' service, spend much of their time trying to get transfers to other departments. The clerical starting pay is extremely low (much less than the monthly earnings of a daily labourer) whilst it is many years before a clerk can reach a time-scale pay on which he can live in comparative comfort and begin to consider saving. So hard is the struggle for existence that many of the clerks are worn out before they are 35 and it is difficult to find men suitable for the senior posts of head clerk, etc. The pay of the clerical establishment must have attention soon or the service in this (and other) department will be in danger of a breakdown.

93. The present system of clerical training gives most unsatisfactory results. The recruit is posted to an office and gradually acquires knowledge of his work; but it is often years before he is really earning his keep and, if useless, his services are not normally dispensed with until he has failed three times in the departmental examination. In order to improve the quality of the clerical establishment it might be advisable, therefore, to have a

training course for the clerks. At the end of, say, three months or so, examinations could be held which would weed out the hopeless and incompetent. Government would have to pay the men under training some maintenance allowance but the total cost could not be much.

94. For the past few years the general standard of recruits for the gazetted, ranger and subordinate posts of the Forest Department has not been good and to ensure an efficient service it appears essential to permit recruitment from the whole of India rather than from Sind only. It will be a waste of money to embark on the enormous expansion of activities suggested in this note if a competent service cannot be maintained.

It might also be advantageous to continue some recruitment of Europeans as, though the Dehra Dun training is excellent, the Indian forest officer does not seem to have such a broad view of his profession as the European trained officer. He is often inclined to attach too much importance to immediate results and forestry is a long-term business. Over-keenness to show, for instance, increased revenue may eventually have serious effects on the general productivity of the estate.

95. Finally—the housing of the forest staff is, generally speaking, deplorable. In the past, because the forests have been considered solely as a source of revenue, any expenditure for amenity provisions for the staff has been reduced to the lowest possible figure and quarters (and offices) have had to be of *katcha* construction which soon become "tumble-down." There is no reason why most of the Forest Department staff should not be as well housed as the staff of P. W. D. and early action is required.

A housing programme was drawn up in 1940 but little progress has been made because of the war. Housing construction must be restarted on a small scale now and as soon as possible the effort must be greatly expanded so that within a very few years essential housing is provided.

PART V

Finance

96. The cost of the developments proposed will be great. In the riverain areas over four lakh acres of wasteland (para. 60) may be afforested and, though the sale value of such land is small, the total capital value will be considerable. The 40,000 acres of land to be turned into forest near the desert (para. 49) will also have comparatively small capital value but the land required for the 1,50,000 acres of irrigated plantations to be established when the new barrages are functioning (para. 64) would fetch in the open market not less than $1\frac{1}{2}$ crores of rupees and perhaps more. The cost of irrigation channels to distribute water and other development works will total lakhs of rupees and probably the full capital expenditure required will amount to not less than rupees four crores.

97. Forest earnings, however, have vastly increased and should continue at a very much higher level than in pre-war days and the bulk of the surpluses should go into a sinking fund to be used for the development of the estate. A proposal is before Government that one-third of the surplus revenues should be put into the sinking fund; but it is now suggested that any surplus above rupees eight lakhs (which is twice the average pre-war figure) should be put aside for as long as the war lasts for capital expenditure.

In 1942-43 the surplus was Rs. 11 lakhs, in 1943-44 Rs. 28 lakhs and in 1944-45 should be about Rs. 35 lakhs, so, if the proposal is accepted, the sinking fund will amount to about rupees half a crore by the end of 1944-45. If this policy is continued it should be possible, during the 25 years or so it will take to carry out all the proposed developments, to pay for most of the capital costs out of earnings. Whether this can be done or not the expansion and development of the forests is essential for the wellbeing of the whole province and must be carried out whatever the cost.

98. During the next few years the expenditure on establishment and works will gradually rise and by about 1950 will be not less than 12 lakhs. In the following decade it will almost certainly increase further to perhaps Rs. 20 lakhs.

99. What level the forest revenues will eventually reach it is impossible to foretell. The Changa Manga irrigated plantation in the Punjab was established about 1866 and soon made good profits after meeting all interest charges on capital and gradually paid off the latter until the estate was free from debt by

about 1916. Pre-war, when prices were comparatively low, this plantation was earning about Rs. 16 nett a year an acre. There is no reason why the Sind irrigated plantations should not earn annually at least rupees eight an acre nett and as it is proposed to establish over three lakh acres of these plantations a surplus of Rs. 25 lakhs annually should be realised in due course apart from earnings from the other parts of the estate.

PART VI

FIVE YEAR PROGRAMME

100. It should be possible to carry out the following items within five years of the end of the war if Government lay down their policy now (para. 83) and appoint *immediately* a conservator of forests development and begin to recruit the staff he will require :

(*i*) The demarcation and settlement of the riverain wastelands to be afforested (para. 60) and the settlement of the existing forest boundaries.

(*ii*) The demarcation and settlement of the 40,000 acres of land to be converted into forest in the Thar Parkar and adjoining districts (para. 49).

(*iii*) The demarcation of the desert and hill areas to be declared reserved forest and the laying out of the experimental enclosures (paras. 46, 53, 54 and 55).

(*iv*) The further expansion of the irrigated plantations by 30,000 acres or so and the establishment of orchards in all irrigated plantation areas (paras. 72 and 74).

(*v*) The selection of areas to be converted into plantations when the lower Sind barrage begins to function (para. 64).

(*vi*) The establishment of tree growth on the larger privately-owned estates (para. 39).

(*vii*) The planting of roadside avenues along all roads on which further developments are not intended (para. 40).

(*viii*) The complete afforestation of the P. W. D. estate (para. 40) and of the Haleji *dhand* area (para. 42).

(*ix*) Much of the development and research required in connection with the existing forest areas (paras. 65—70).

(*x*) The establishment of forestry and clerks training courses (paras. 91 and 93).

(*xi*) Half the housing programme necessary (para. 95).

(*xii*) *All the essential foundations for a properly balanced provincial economy.*

PARTVII

SUMMARY

101. In Part I of the note is given a brief description of the province, its area, forest growth and wood outturn.

102. Part II describes the objectives aimed at. These are : balanced rural economy, protection of desert, afforestation of hills, providing amenities such as roadside avenues and green belts, etc., and expansion and development of the forests so that their annual yield should be 50 to 60 million c.ft. which is three times the pre-war yield from this source.

103. In Part III are given recommendations regarding the achievement of the above objectives by new afforestation and improvements of the existing estate. Proposals are also made for research work as well as policy to be adopted in respect of Sind forests and woodlands.

104. Part IV contains proposals regarding increase in the staff, recruitment thereto, betterment of pay and prospects of the subordinates and clerks and housing of subordinates.

105. Part V discusses capital outlay involved in the proposed development and how it can be found and gives estimates of revenue and expenditure in the future.

106. In Part VI is indicated what can be achieved during the five years following the end of war.

(*Concluded.*)

Fig. I

Bavali teak plantation in Mysore district showing the typical branching of teak trees from seed of Mysore origin. The upward bend of the branches has been compared to that of an inverted sabre.

(Photo : Author ; Jany. 1941)

Fig. II

All-India seed origin experimental plot at Kakankote; Nilambur origin, to the left of the cleared line, and Mysore origin. Nilambur origin proved better than all the others as regards germination, seedling development and survival after transplanting.

(Photo : Author ; Jany. 1941)

TEAK-SEED ORIGIN EXPERIMENTS IN MYSORE.

By Krishnaswami Kadambi, D.Sc.

(*Working Plan Officer, Mysore*)

From the very early days of teak planting in Mysore—the sixties of the last century—when the planting of teak became a more or less regular annual activity of the forest department, it had been observed by forest officers that teak seeds from Kakankote area in Mysore district produce characteristically branchy trees when introduced into Shimoga and Kadur districts, and the branches, which are always too strongly developed, arch upwards like an 'inverted sabre,' and even in plantations raised in their own home this seed produces similar branchy trees (*see* Fig. I, Plate 9). It was also known that Mysore seed when used in plantations results in stunted, relatively low, branchy trees with a relatively large number of insect galls. It has also been noticed by working plan parties in recent years that the incidence of defoliator attack is generally more severe for Mysore teak and that usually trees from Mysore seed shed their leaves earlier and sprout later in the season than do those of Shimoga origin although the rainfall in the heart of the Mysore teak zone is more than in the Shimoga-Kadur zone by about 10 inches. Though not distantly separated on the map of India and their climatic conditions not very distinct from each other, trees of these two seed origins show very distinct morphological peculiarities.

The following broad differences have been noticed:

1—Bole Form and Crown Formation

Mysore origin	*Shimoga origin*
Trees relatively short and less well formed, branchy, with the powerful branches arching upwards like an inverted sabre, crowns generally less full and round-headed, displaying a greater tendency to stag-headedness, less high than broad in the adult trees.	Trees with relatively taller and better formed boles, less branchy, with fuller, round headed crowns, higher than broad in the adult trees.

2. Leaf Description

(*i*) *Length*

Very varying according to the available moisture and depth of soil; generally 11 to 19 inches.	Very varying according to the available moisture and depth of soil; 12 to 17 inches.

(*ii*) *Shape*

Oblanceolate to obovate, leaf-base cuneate, rounded or obtuse.	Oblanceolate to obovate, leaf-base truncate, rounded, cuneate or acute.

(*iii*) *Colour of Veins*

Markedly whitish, not hairy.	Brownish, hairy.

(*iv*) *Surface*

(*a*) *Lower*

Prominently glistening in the sun, feel relatively smooth.	Hairy, dull, feel rough.

(*b*) *Upper*

Whitish veins prominent, feel less scabrid.	Brownish veins not prominent, feel scabrid.

(*v*) *Colour of leaf*

(*a*) *Lower*

Whitish, glistening.	Dull green with sometimes brownish tinge owing to abundance of hair.

(v) Upper	
Moderately light-green.	Dark-green.
(vi) Texture	
Leathery.	Papery, more or less.
(vii) Petiole	
Distinctly petiolate, the petiole being half an inch long, more or less.	Not distinctly petiolate, or only provided with a very short petiole about $\frac{1}{8}$ inch long or less.
(viii) Leaf tip	
Bluntly acute to acute	Generally acute.
(ix) Leaf margin	
Generally wavy; no teeth	More or less dentate.

THE EXPERIMENTAL PLOTS OF MYSORE

As the outcome of a resolution passed at the silvicultural conference held in 1929 co-operative experiments on the effect of the origin of teak seed in the growth of teak plantations raised from it were started in several provinces and Indian states and among the latter was also Mysore. The resolution on the subject in the silvicultural conference of 1939 ran as follows:

Resolved that:

(1) As it has been adequately demonstrated that many individual and racial characteristics within a tree species may be inherited, systematic investigation of possible inheritance of suspected superior or inferior forms should be extended to all species used or likely to be used extensively in plantation work wherever such forms deviate from the normal to an extent which may affect financial returns.

(2) * * * * * *

(3) It is important that seed-origin experiments should be maintained on an approved and, where possible, standardised method. The procedure proposed by the Central Silviculturist is approved and should be followed but should be modified from time to time as a result of further experience.

In Mysore state experimental plots were opened in three different places, one at a place called Machurtittu in Kakankote state forest and adjoining the Mysore-Manantoddy road, a second close to Bandigudda about 15 miles south-east of Bhadravati in Shimoga district and a third, also in Shimoga district, about six miles south of Bhadravati. The general object of these experiments is to study the influence of teak seed of different localities on the plants and the crop produced at different places within Mysore. The purpose of these plots is to establish crops of teak from different origins in which sample plots can be laid out to study primarily comparative rates and habit of growth as well as the quality of timber.

The seeds received from different localities were carefully labelled, raised in nursery beds according to the standard procedure and the plants, two to three months old, of different origins, also labelled, were transported to the spot and planted entire six feet by six feet. The failures were refilled by transplanting entires in the succeeding years.

For various reasons, the chief ones among them being poor initial stocking and inadequate fire protection and the consequent annual fire damage the third plot had to be abandoned soon after the start. Thus only two plots have remained under observation, one at Kakankote and another at Bandigudda.

The former is set on clayey loam with a substratum of gravel and gneiss. quartz boulders appear as outcrops in the vicinity of the plot. The latter is set on sandy loam with underlying granite. The rainfall at Kakankote averages round 50 inches while that at Bandigudda is about 40 inches. Both localities lie in the regions of the natural range of teak in Mysore.

There are a few obvious defects in the initial layout and maintenance of these experiments which have to be recorded. They are:

(1) Seeds of some origins were received late and consequently there was belated germination and the entires were smaller than others at the beginning.

(2) Repeated and heavy replacements sometimes running over three to four years after the first stocking resulted in unequal-aged and unequal-sized plants.

(3) Non-removal of coppice regrowth from old stools present at the time of planting has resulted in some impurity of the crop raised from various seed origins.

(4) Proper randomization and adequate replication are both wanting. There is only a single set of plants of each origin in each of the two localities and the results from them cannot therefore be conclusive.

(5) There has also been slight lack of uniformity in the site qualities of the sub-plots.

The following seed origins have been tried:

Serial No.	*Province*	*Zone*	*Locality*	*Rainfall (Ins.)*
1.	Burma	.. North (Lat. 24° N.)	Myitkina	.. 79
2.	Burma	.. South (Lat. 17°N.)	Tharrawady	.. 88
3.	Bombay	.. South—moist	E. D. Kanara	.. 96
4.	Bombay	.. North—dry	West-Khandesh	.. 40
5.	Madras	.. Moist	Nilambur	.. 110
6.	Madras	.. Intermediate	Palghat	.. 45
7.	Mysore	.. Moist (*)	Kakankote	.. 50
8.	Mysore	.. Dry (*)	Bandigudda	.. 40

In the Bandigudda plot only four origins, namely, serial Nos. 4, 5, 7 and 8 above, have been introduced while in the one at Kakankote all the origins except serial No. 4 have been tried.

Each year about 10 per cent. of the mean dominants in each sub-plot are measured and their heights and girths recorded. The results have been shown in the appendix on page 269.

The following cultural operations have been carried out so far:

Kakankote Plot

Year	*Description of operations*
1933-34	.. Weed cutting, replacing 2,040 failures and scraping round 4,200 plants.
1934-35	.. Weed cutting, scraping round 2,000 plants, cleaning, cutting back of malformed individuals, making a trench all round the plantation to minimise elephant damage. There was heavy elephant damage this year.
1935 to 1941.	Weeding and cleaning as and when required.

Bandigudda Plot

1932-33	.. Weeding and replacement of failures.
1933-34	.. Ditto.
1934-35	.. Ditto.
1935-36	.. Ditto.

From the very start it was observed that Nilambur origin was the best as regards germination, seedling development and survival after transplanting (*see* Fig II, Plate 9.) It is likely that better germination in this case was the result of selecting seed before despatch.

In a paper contributed to the 5th silvicultural conference (December, 1939) on the subject Mr. J. N. Sen Gupta has recorded the following tentative conclusion:

" . . . it would appear that in spite of some eventual shortcomings in the initial stocking and later maintenance of the experimental plots the investigation has so far generally indicated the superiority of seed of

(*) It would have been more appropriate to call these two simply Mysore and Shimoga origins since there is not much difference in the rainfall of the two localities.

local origin to those of others in the regions of the natural range of teak as far as ease of establishment and early development extending over a period of five to eight years is concerned. This confirms the tentative conclusions reported in the last conference* that "in a general way the local origin appears to be the most suited." The Nilambur origin has, however, done very well also in relatively dry zones of C.P., U.P. and Mysore whereas the moist climate of Dehra Dun shows a preference to the Burma origins."

An examination of the figures in the appendix shows that plants of Nilambur origin are the best in both the Mysore experimental plots. Next to Nilambur stands Shimoga (Mysore dry) origin and this is followed by the Palghat (Madras intermediate) origin, while the local origin occupies only the fourth place in the Kakankote experimental plot (Mysore moist zone). In the Bandigudda experimental plot, also, local (Mysore dry) origin stands next to Nilambur origin and this is followed by the Kakankote (Mysore moist) origin which (here) therefore, occupies the third place.

Thus the present indications are that under Mysore conditions and for the Mysore teak zones, both moist and dry, Nilambur origin seems to be the most suitable and the next best seems to be Shimoga (Mysore dry) origin.

The Mysore plots are now 13 to 14 years old and it is seen from the figures in the appendix (page 269) that Shimoga (Mysore dry) origin has all along been inferior to Nilambur origin but *superior* to Kakankote (Mysore moist) origin. This last fact, namely, the faster growth of Shimoga teak compared to Mysore teak agrees with the long-standing belief of forestmen in Mysore—belief which is almost a century old. The figures also show that the Mysore dry origin, though somewhat behind Nilambur origin in height growth, is actually better than that origin in its own home.

It has been the custom in Mysore to distribute teak seed from Kakankote (Mysore moist origin) to other parts of the state and sometimes even to the adjoining portions of British India and Coorg. Trees produced from this seed could readily be recognised by their characteristic branching, whitish colour of their leaf veins and glistening, smooth leaf under surface, and they may be seen over most of the artificially regenerated teak areas of Mysore state and in some of the older plantations of Coorg. It would be advantageous to use Shimoga seed for all plantations in Mysore.

As regards the desirability of substituting Nilambur seed for Shimoga seed it is probably too early to decide this point since trees of Mysore dry origin have been fast approaching those of Nilambur origin in height and we have to wait for some more time to see which of these will ultimately be the better of the two.

As already mentioned the Mysore plot have defects in their initial layout and maintenance and the results from them cannot therefore claim to be conclusive, but it is significant that indications from them go to confirm the long-standing belief of Mysore forest officers that Shimoga seed is better than Mysore seed for plantation purposes.

* Silvicultural Conference of 1934.

APPENDIX

EXPERIMENTAL PLOT—KAKANKTEO—1932

MEASUREMENTS OF MEAN DOMINANTS IN FEET

No.	Seed Origin	Locality	1937 Height	1937 Girth	1938 Height	1938 Girth	1939 Height	1939 Girth	1940 Height	1940 Girth	1941 Height	1941 Girth	1942 Height	1942 Girth	1943 Height	1943 Girth	1944 Height	1944 Girth
			ft. in.		ft. in.		ft. in.		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
1	Burma (North) ..	Myitkina ..	14 2	*Not recorded.*	14 6	*Not recorded.*	14 9	*Not recorded.*	14 11	0 6	15 1½	0 6¾	18 3	0 8½	21 7	0 10	25 2	1 0½
2	Burma (South) ..	Tharrawadi ..	11 9		15 4		16 9		17 6	0 7¼	18 10	0 8½	20 11	0 9¼	23 4	0 10½	25 1	1 0
3	Bombay (South).	E. D. Kanara ..	11 10		13 9		14 0		15 2	0 5¾	15 6	0 7	16 9	0 8¾	18 2	0 10¼	19 6	1 0
5	Madras (Moist) ..	Nilambur ..	16 5		17 8		19 8		22 4	0 9	25 9½	0 10½	28 1	1 0½	30 3	1 2¼	32 5	1 4½
6	Madras (Intermediate).	Palghat ..	14 11		15 10		17 9		21 11	0 9¼	25 9	0 10¾	26 10	0 11⅝	28 4	1 1¼	30 2	1 3
7	Mysore (Moist) ×	Kakankote ..	12 0		14 3		16 0		17 4	0 5¾	18 11	0 7	21 10	0 9½	24 9	1 0½	27 0	1 3
8	Mysore (Dry) ..	Shimoga ..	15 6		18 8		20 6		21 10	0 7¾	24 5½	0 9¾	27 5	0 11¾	29 6	1 1½	32 0	1 3½

× Local origin.

EXPERIMENTAL PLOT—BANDIGUDDA.

4	Bombay (North).	West Khandesh	11 6	*Not received*	13 2	*Not received*	15 8	*Not received*	17 10	0 8	19 0½	0 91/5	20 1	0 10¼	21 4	0 11½	22 9	1 0⅓
5	Madras (Moist) ..	Nilambur ..	27 9		30 0		31 8		32 10	0 9⅝	34 4	0 11	36 8	1 0¼	37 2	1 2	39 3	1 4
7	Mysore (Moist) ..	Kakankote ..	12 6		16 8		19 10		21 0	0 9¾	22 4	0 10½	23 10	0 11¾	25 4	1 0½	27 2	1 2¼
8	Mysore (Dry) +	Shimoga ..	16 3		21 4		25 6		27 8	0 11⅝	29 11	1 0	32 0	1 1¾	33 10	1 3½	35 6	1 6

+ Local origin.

THE PLACE OF MECHANISED EQUIPMENT IN INDIAN SOIL CONSERVATION*

BY R. MACLAGAN GORRIE, D.SC., F.R.S.E., I.F.S.

THE CHAIRMAN: It is a very great pleasure to me to preside to-day and to introduce Dr. Maclagan Gorrie to you. He is a distinguished forest officer, and has made a long and extensive study of the subject of the paper—a subject upon which I think it is correct to describe him as the greatest authority in India. It may seem that the subject of the paper is more concerned with agriculture than with forestry, but it is a subject upon which both the agricultural and forest officers can co-operate most closely to the great benefit of India.

The following paper was then read:

I am grateful to the Royal Society of Arts for this further opportunity of putting before its members another report on the progress of our fight against soil erosion, as it is now 6½ years since my previous contribution on this subject. In the interval many projects have been delayed or cut down as most of our forest officers have been fully employed on meeting war demands for timber but even so, some progress has been made, and the war itself has radically altered our ideas of what is humanly possible of achievement.

1. The world problem of deterioration of soil, and in many countries the parallel phenomenon of increasing density of population, render it essential that we in the British Empire should marshal our resources of men and material to make all available land productive. This war has witnessed the supply of vast quantities of mechanical transport and heavy machinery for the moving of earth, the digging of trenches and of tank-ditches, the consolidation of surfaces for air-landing strips, and so forth. It has also witnessed the training of many thousands of men to handle this equipment, with the surprising result that the more primitive and unmechanised countries such as India, Burma Ceylon, Sudan and many of the Crown colonies will suddenly find themselves wealthy in mechanically-trained men, where previously anything more than hand labour and the moving of head-loads of soil in baskets was unknown.

2. How can we keep these trained drivers and mechanics fully employed, whether they have returned to civilian life or are available for agricultural projects while still serving in the forces? The first essential will be to secure machinery suitable for our purposes as soon as it can be spared from its war-time role, and organise a redistribution to countries and administrative units which can make good use of it. Much of it has been acquired by the British Empire forces from America by Lend-Lease, and its reallocation for a further spell and for peaceful pursuits would presumably have to be covered by a fresh agreement with the supplying country, because, so far this equipment has been loaned for war purposes only. We can, I think, safely presume that this could readily be arranged, because it is hardly likely that the United States would wish to have part-worn machinery returned to her. It would, in fact, be in her interests to have the use of mechanised equipment popularised in these more backward countries so as to secure larger and more permanent markets for her peace-time production of earth-moving machinery. I note in to-day's newspapers that the Government of India is trying to procure 11,000 tractors for the cultivation of reclaimed waste land, but in view of continued demands for more war-like equipment the chances of early delivery of straight agricultural machinery are likely to be poor for many months ahead.

The problem is by no means confined to India; almost every one of our dominions, colonial possessions and mandated territories, has its own problem of soil erosion, and the conservation programme could in almost all cases be amplified and extended by exploiting our new knowledge and experience in mechanised earth moving.

3. The type of equipment actually available differs radically from what is known as

*A paper read before the India and Burma Section of the Royal Society of Arts, 16th November, 1944, Sir Frank Noyce, K.C.S.I., C.B.E., in the Chair

"farm machinery" in Great Britain. It consists largely of bulldozers and roadgraders whose main job is to cut away and level rough ground as a preliminary in the alignment of roads and landing grounds. Then, in addition, there are smaller numbers of heavy ditching ploughs and earth scoops for cutting trenches and tank ditches. All such machines can be employed direct in almost any type of contouring, terracing or levelling of fields. Then there are others, such as grabbers and hoists as well as much larger quantities of the more stereotyped military equipment such as tanks, heavy lorries, armoured carriers, ordinary motor trucks and other haulage equipment. Last how far such purely haulage equipment can be made use of directly in soil conservation work depends of course on the contours of the ground and the type of ridging, terracing or wall building which best meets the local requirements of erosion control technique. For the recent fighting in Burma light tanks have been fitted with an adjustable scoop or share such as is carried by a typical roadgrader.

4. There is a general impression amongst farmers in most countries that the mechanisation of farming will automatically cause a reduction in the number of labour hands employed, but this is not necessarily so. In the type of soil conservation work now envisaged for India very large tracts will be opened up to more intensive settlement, but these are now supporting only a scattered population of graziers or cultivators who can barely make a living. Such tracts in the first instance cannot be rendered cultivable by hand labour alone. Having established cultivators on parcels of treated land, it is then open for decision just how far the ordinary farm work of seasonal cultivation can be undertaken mechanically or by hand. In most tropical communities where labour is cheap and plentiful, it is manifestly unwise to introduce farm machinery which will displace hand labour merely for the sake of reducing the cost of production. The aim in all such projects, and in fact their only justification, is to ensure a better output of food per acre plus a high output per man, thus giving profitable employment to a maximum number of people. There is, however, much scope for the introduction of improved farm implements such as the Ford-Ferguson equipment where this will give a higher standard of cultivation.

5. No land improvement scheme of this sort has been worked out yet in its entirety in India because the available machinery is still employed on war work, but the other essential phases of such resettlement projects have been dealt with, so that the main difficulties are already known and can be assessed. Before going further, it would be as well to state the extent of the practical experience so far gained which would justify recommendations of this sort, remembering that India is such a vast and diverse country that generalities are always dangerous. The experience gained in one province or state may not necessarily be applicable elsewhere. The human element must first be assessed. What is feasible in the Punjab where intelligent and forceful cultivators are already applying the co-operative principle to many of their farming problems may be ridiculous if applied hastily to the more primitive Central Provinces or Orissa peasantry, and again there is always the variant of excessive or deficient rainfall.

6. Resume of Work Done in Provinces by Civil, Irrigation, Agriculture and Forest Departments.

A—*In the Punjab*

(*i*) Many small demonstration areas have established the teaching and practice of *watt bandi* (contour terracing with each field fashioned to a saucer shape behind its watt or ridge). These are mostly in rolling foothill country where gullying has become a serious menace. Some of this work has actually been carried out with the use of road-grader machines in Gurdaspur district.

(*ii*) Consolidation of scattered and fragmented holdings can be legally enforced wherever 60 per cent of the cultivators elect to ask for it. There is a separate department of civil administration handling this, several thousands of villages have already been worked over and there is a waiting list of villages which have asked to be done. This forms a golden opportunity to introduce a realignment based primarily upon the contouring of the whole area.

(*iii*) Several individual landowners have adopted mechanical means for contouring their land and carrying out subsequent ordinary and deep ploughing. Worthy of special note is the use of a trailer "Killefer" plough for sub-soiling on the Ingram

estate at Palwal in Gurgaon district. This has been a conspicuous success, but can only be undertaken with mechanical traction because the draught animals of the country are quite incapable of drawing this plough through the soil at a depth of 20 to 24 inches. The object is not to turn over deep soil on to the surface but to fracture the deeper subsoil *in situ* without bringing it on top. This avoids the temporary loss of fertility which so often results from deep ploughing. The Agriculture Research Council has arranged for similar sub-soiling work in Britain. But conditions are so very different that I wish to stress the almost unlimited possibilities of using this principle of sub-soiling to increase the porosity of tropical and semi-tropical soils.

(*iv*) Orthodox irrigation using well or river water has been extended, about as far as possible, so that further catching or saving of water requires an entirely new technique if the desert fringe is to be rendered permanently habitable to more than itinerant graziers.

(*v*) Soil conservation work in the Pabbi Hills and Hoshiarpur and Gurdaspur has demonstrated that almost any type of torrent can be tamed by tapping the run-off and improving the porosity of the catchment area, given sufficient capacity for moving soil and given also protection of the resultant vegetation.

B *In the United Provinces*

(*i*) Well irrigation and the pumping of underground water by means of hydro-electric power from relatively shallow depths is being rapidly developed in areas which are fortunate enough to have a fairly high underground water table level.

(*ii*) Demonstrations on the *usar* or salt-petre-drugged waste lands have shown that much can be done by contouring and trapping the surface wash, the object being not plough-land but a crop of fodder grass.

(*iii*) The Etawah experiments have shown that badly ravined land can be made productive slowly by re-grassing, and more quickly by contour ridging.

C—*In Rajputana*

(*i*) Jodhpur State has adopted mechanical tractors for the working of a 15,000-acre farm with excellent results. They also are trying sub-soiling.

(*ii*) Sir William Stampe's recent survey has shown that there is literally no underground water throughout large tracts of Rajputana and the adjoining desert fringe in the Punjab and Sind. This emphasises the need for a new technique in trapping and using the whole of the rainfall wherever it can be held and diverted into cultivable blocks.

D *In Bombay*

(*i*) The two *bandi* divisions run by the Agriculture Department for the extension and improvement of terracing and ridging of fields, have fully justified their value in adapting the contouring principle to local labour conditions and black cotton soil. A recent bequest by a well-known Bombay industrialist makes a wider extension of this work possible.

(*ii*) Improvement plans for two *tahsils* have been prepared by a group of road and agricultural engineers aiming at raising the general standard of living by giving every village a cement or macadamised approach road and every block of fields a service road for farm machinery. This type of development immediately suggests better contouring of all fields.

(*iii*) The Sholapur run-off experiments have shown that exceedingly high soil wastage occurs on even the gentlest of slopes, pointing to the need for extensive contouring schemes to be applied to practically all types of plough land.

(*iv*) Baroda State, which is geographically in Bombay area, has initiated run-off control and diversion of surface water, combined in some instances with collective farming or consolidation of holdings on a profit-sharing basis.

E. *In Central Provinces*

The backwardness of the peasantry and the absence during the last few years of any responsible elected government have rendered it impossible to introduce any active soil conservation programme, but recent observation has shown clearly that the marginal plough lands throughout the central plateau are suffering seriously from erosion by sheet-wash. Most crop failures are undoubtedly due to poor agricultural practice rather than to actual deficits of rainfall in country which has ample supplies of water running to waste at certain seasons.

F—*In Bihar and Orissa*

The heavily populated uplands of Bihar are in an even worse state than those of the Central Provinces, but the primeval jungles of the Eastern Orissa States are at a much earlier stage of degradation owing to the primitive hillman's shifting cultivation. The Orissa rulers have recently agreed to the appointment of an advisory committee and there is now some prospect of carrying propaganda and the teaching of better farming practices to these very primitive people. The safety of the upper reaches of several important river catchments is affected, and the sparseness of available labour might justify the use of machinery for extensive contouring.

G—*In India at the Centre*

(*i*) The war has interrupted a project of the Imperial Council of Agriculture Research under which an officer with experience in soil conservation technique was to have been put on special duty to prepare a general summary of the erosion conditions over the whole of India, and a more detailed "working plan" outlining the actual work required for one large river catchment, possibly the Mahanadi.

(*ii*) The so-called "Bombay Plan" produced by a group of industrialists is based on the findings of the National Planning Committee's Report of 1939 and proposes the allocation of very large sums to soil conservation as an integral part of agricultural and industrial improvement. The scheme covers 15 years in three sections of five years, but the details have yet to be worked out.

7. This completes my outline of recent developments in India, but before proposing a policy for India, let us glance at evidence from other countries.

(*i*) The war has unfortunately interrupted the liaison which had been established by forest officers in the various countries of the Empire and those employed on soil conservation in the U.S.A. Ten years have elapsed since the publication as an Oxford Forestry memoir of my book. *The Use and Misuse of Land.* This attempted to show how far American experience could be applied to our Indian and Empire conditions, but in the interval great strides have been made in America. I consider that it is absolutely essential that closer contacts be established as soon as possible after the war so that Empire countries may profit by America's recent progress, *particularly their experience* in the management of programmes by a very small committee of experts, the so-called "district" voting whereby minority objectors can be overruled, and the extent to which mechanical equipment has been adopted and adapted to local needs.

(*ii*) The help we can get from Russian experience must not be overlooked, for there is no doubt that some form of collective farming could be applied with advantage in the Punjab and many other places. A proposal to make a study tour in Russia to see the classic steppe shelterbelts in 1938 was vetoed by the Government of India, and now most of these must have been destroyed by war. Shelterbelts form an intrinsic part of any comprehensive land conservation programme.

(*iii*) The use of mechanical tractors for deep trenching in peat and rough boggy land has revolutionised Scottish planting technique within the last few years. Downhill trenching gives immediate improvement in surface drainage. This is a departure from the usual contouring practice, but the point made here is not detail of work but the fact that mechanised equipment is being put to use for new purposes.

(*iv*) In the Sudan and several other African colonies, ambitious soil conservation programmes involving an enromous amount of earth moving are under consideration by the governments concerned.

(*v*) A recent leader in a prominent Colombo paper called attention to the Baroda experiments and advocated similar action for Ceylon.

8. I now wish to discuss proposals based on zones of available moisture.

As water is the all-important factor in any extension of cultivation, I shall deal briefly with three very roughly-defined zones—wet, middling and arid.

(*i*) *Over 60 inches of rainfall.* In hilly country the main object must be to keep catchments in as absorptive a condition as possible. Hitherto it has been the fashion amongst foresters to emphasise that nature is capable of growing a vegetative cover which is fully absorptive provided it is

protected from abuse. This is usually a council of perfection which every increase in population renders less likely, and we must therefore be prepared to interfere in nature's favour rather than to her detriment, as has almost invariably been the case in past land "development." By means of contouring the more lightly-wooded hill lands as well as the cultivated clearings, we can control the run-off to a very considerable extent, allowing only the surplus from the very heaviest storms to escape into the rivers. The overflow escape channels and discharge weirs will carry a very heavy strain and it is on their efficiency that success or failure will depend.

On level lands with high rainfall such as the plains of Bengal, the problem is to get rid of the surplus water quickly. Millions of acres could be made more productive with an efficient system of field drainage, and for this, mechanical ditches and trench cutting machinery would be invaluable.

(*ii*) Secondly, the middle zone *between about* 30 *to* 60 *inches rainfall.* This includes the vast majority of upland cultivation depending directly on rainfall only, and it also includes a large part of the well irrigation which supplements rainfall in the flatter lands. With rainfall alone, the successful maturing of crops is usually in direct proportion to the amount of the previous monsoon which has been caught and stored by the soil. Fields which, owing to steep slope or to a hard-baked fallow surface, fail to absorb a reasonable amount of water, are bound to be the first to show crop failures. Contouring and better manuring is the only sound way of reducing such failures.

Similar, uncultivated ground trodden hard by grazing herds, and shorn of its legitimate cover of grass or scrub jungle, can only be made more absorptive by the application of the contour principle. Actually contour trenching or ridging has the effect of adding many inches to the quantity of rain absorbed by the ground, and the flora in the immediate neighbourhood of each trench, and often for many yards downhill from it shows a quite obvious ecological improvement. As an example of what can be achieved in this way, there is the Salt Lake City catchment in the Wasatch Mountains of Utah, where a Civilian Conservation Corps project in 1934 covered many hundreds of acres of steep hillside with contour trenches; the immediate result was a dense crop of grass and bushes on what had previously been heavily grazed open aspen scrub, and the eventual result has been a steady improvement in floods prevented and seasonal run-off stabilised and stored, with a consequent recrudescence of perennial springs which had previously died away. Similar but less ambitious projects are under way in the Punjab and Bihar.

(*iii*) *Arid conditions* (*below* 30 *inches rainfall*). We now come to the crucial area where the fight between over-crowded humanity and advancing desert is being fought out. Apart from the larger irrigation projects which supply lands of low rainfall, the standard of agriculture along the desert fringe is woefully poor. In many places such as the Southern Punjab districts of Gurgaon, Hissar, Ferozepore and Mianwali, the percentage of crops brought to a successful maturity compared with the area ploughed and sown is lamentably small. The cultivator sticks to hardy but poor-yielding crops such as gram because he does get a higher percentage matured. If such land is ever to support a higher population with reasonable freedom from under-nourishment, let alone famine, I suggest that a new approach is needed to the whole question of farming methods in this low rainfall zone.

We must plan in terms of the total available water, whether rainfall, established canal facilities, or underground supplies. The vagaries of the rainfall below the annual normal can to a great extent be off-set by catching and holding a larger percentage of the total fall. Where perennial canals exist, the cultivators have generally got careless and extravagant in their use of water. Great extensions of cultivation beyond the tails of existing canals could be undertaken with water saved under a more rigorous economy. Surplus water from monsoon floods could be fed down existing channels and passed out on to land parcelled out in a pattern of contour ridges and livestock watering ponds. The crucial factor is the field capacity or moisture content of the soil at given depths at the close of the monsoon. A dry layer at 2 to 4 feet would probably be disastrous for most cereal crops. With a good technique of pre-monsoon ploughing aimed at maximum monsoon absorption, alluvial land can be made to store sufficient moisture to ripen a cold-weather crop in the

following winter even if the winter rains fail completely. This has been demonstrated by recent work at the New Delhi experimental farm which has replaced the old Pusa institute.

Even where there are no canals nor any underground moisture reserves within the reach of crop roots, as is the case in Rajputana, much might be done by establishing a series of small self-contained artificial catchments so that out of a block of say 6 acres the run-off from the whole is turned on to, and absorbed by, the lowest-lying acre or two, from which the cultivator could secure a good crop, no matter whether the rest of the area could be sown or not. Even with a rainfall as low as 10 inches falling in a few torrential and sudden storms, if 50 per cent of the run-off is diverted on to, and absorbed by, a selected field whose absorptive condition is made a primary charge, a considerable range of valuable cereal and vegetable crops could be raised.

Alternatively in these 6-acre blocks strip-cropping on a series of narrow contoured fields could be used to exploit some local adaptation of the new Uganda practice of using any coarse cane grass to build up the soil during a 3 or 4-year fallow. The tall grass *Saccharum munja* should lend itself to this use in arid areas. Such tall grasses can also be used for shelter-belts by planting clumps densely on contour ridges to protect the crop to leaward from the hot winds of the Western Punjab and Sind, where the rearing of trees and bushes is slow and difficult.

9. Proposals based on Regimentation of Labour.

Wherever land settlement schemes are being worked out on behalf of soldiers, the manual labour required to accompany and supplement the tractor work could be provided by the demobilised men themselves, working in a *district pioneer company* which would retain each man's services until his homestead was rendered fit for occupation and his land fit to till. The machinery would be held and worked by the province or other civil government unit which would have to take over the machinery from the army and build up by some arrangement of loan or transfer of services enough technically trained staff to run the machines and maintenance workshops. A strong and efficient workshop unit which could travel from district to district would be essential at least until such time as the districts themselves became capable of undertaking heavy repair jobs. The need for a strong repair organisation is vital to the success of any mechanised project.

As in the case of the American Civilian Conservation Corps, the proposed machinery company and the auxiliary district pioneer companies could be officered partly by technically trained men who would arrange and control the field work, and partly by a quasi-military organisation who would attend to discipline, housing, rations and clothing. The bulk of the labour involved could best be done by intending settlers, preferably of agricultural castes who have actually been promised a parcel of land and who thus have a real interest in making the land productive. Where District Soldiers' Boards are already established these should provide a nucleus around which a local organisation could be built up, provided they will accept the help and advice of whatever soil conservation staff can be made available.

10. In closing, I submit that this society should use its great influence to emphasise to our Empire administrators and particularly to the Indian provincial governments, the urgent need in framing their post-war resettlement work to provide funds and procure machinery so that the available manpower and skill can be utilised to the fullest extent. India is already dangerously unbalanced by the war boom in industry: the eating power of the people and particularly of the soldiers has been greatly stimulated but the land which alone can produce their food has been neglected. The land wants not only protection from erosion but also its full share of manuring and the fostering care of well-planned husbandry. The new industries need markets if they are to survive but their only safe market is a contented and prosperous peasantry: the purchasing power of India's million villages can only be raised by developing more fully their one basic natural resource, namely, the soil.

THE CHAIRMAN: I am sure you will agree with me that it would have been better if someone with more expert knowledge of the subject of Dr. Maclagan Gorrie's lecture than I possess had been asked to preside; and will equally agree with the lecturer in the view he has taken in the last sentence of his

paper that the purchasing power of India's million villages can only be raised by developing more fully their one basic natural resource, namely, the soil.

As to the possibility of extending the area under cultivation in India, I have urged here and elsewhere that there is not much to be looked for in that direction from the area which used to be recorded in the "Agricultural Statistics of India" as "Cultivable waste other than fallow," but which is now known as "Other uncultivated land excluding current fallow." Such is the pressure of population in India that if any large proportion of that land could be cultivated it would have been cultivated long ago. None the less there must be included in those figures as well as in the figures of "Land not available for cultivation" quite extensive areas which once were cultivated but which have lost all agricultural value as the result of fluvial action. as well as of the action of the monsoon rains on the sloping hill sides in upland tracts. Even more important than the problem of bringing such lands back to cultivation is to prevent lands which are still cultivable from sinking to the same condition and to restore the fertility of land where it has already suffered. To the solution of this problem in all its aspects Dr. Maclagan Gorrie has made a most valuable contribution. It is not too much to say that the problem of soil erosion is one of the most serious of those facing Indian agriculture. Its seriousness is not generally recognised. The Royal Commission on Agriculture said something about it in their report. but they did not stress its importance as they would have done if they had known as much about the American "Dust Bowl" as we do now.

At that time there were two methods of dealing with the problem. One—in the United Provinces—was by afforestation of ravine land, and the other—in Bombay—was by contour bunding. The Royal Commission recommended that the extent of the damage done by erosion should be investigated, and if it was found that it was proceeding at a pace which justified such a course, schemes for preventing it should be prepared. They suggested that, in Western Bengal, where nothing had been done at all, and in the submontane districts of the Punjab where the methods adopted had not achieved very much success, the feasibility of combining the methods adopted in the United Provinces and Bombay should be investigated. It is disturbing to realise from the paper that so little has been done since then. The Punjab has gone ahead but nothing has been done in Western Bengal and its neighbour, Bihar, and very little elsewhere, except in Bombay. Some information in regard to Bombay is given in the last number of the *Indian Farmer* to reach this country. In that Province where only a little over one million acres of the 29 million acres under cultivation are irrigated by canals. wells and tanks, and where the problem of soil erosion in the Deccan. Khandesh and parts of Gujerat is very serious. for some years past much work has been done at the Dry Farming Research Stations at Sholapur and Bijapur. The results have been embodied in the Bombay Dry Farming System. a simple system of land preparation. tillage and crop cultivation. the main object of which is to conserve as much as possible of available rainfall in the soil and retain it for the use of growing crops.

Of its main features. the one of special importance in the present connection is simple field bunding along the contours of the cultivated area. As has been so often the case in Indian agricultural history, it took famine conditions to drive the importance of this home. It was not till 1942-43 that a really serious effort was made to deal with the problem as a famine work. By the middle of October, 1943, 80,000 areas of land had been completed in Bijapur. 15,000 of which were either forest or waste land. Progress in Sholapur was not so rapid. It was estimated that by the end of March of this year the total would be 175,000 acres.

Some very striking figures are given of what this means to the cultivators. As a result of field tests in Sholapur, the soils of which are shallow, it was found that on fields on which the Bombay Dry Farming System had been adopted, the production of jowar (big millet) had gone up from 89 lbs. per acre to 238 lbs. per acre, and that of straw from 256 lbs. per acre to 447 lbs. per acre. The reports regarding deeper soils show better figures still. The Bombay Government are taking steps to secure that the results of this work shall be permanent. The Land Improvement Schemes Act of 1942 provides legal machinery to ensure that the contour bunds are regularly maintained and kept in good repair.

I should now like to turn to two points in the paper in regard to which I must break a lance with Dr. Maclagan Gorrie. The first is his disparaging remarks about cultivators in the Central Provinces. I do not come from that province myself, but I know most of it fairly well and I maintain that in large areas of it, especially in Berar, there are cultivators whose standard is very high, even compared with that of the Punjab.

It is perhaps hardly fair to Dr. Maclagan Gorrie to mention a sentence in the paper as it reached me, but which he has omitted this afternoon, but I shall venture to do so as it enables me to make a point which I think wants driving home. The sentence ran: "The Russian past experience in establishing collective farming would also be invaluable." That sentence filled me with dismay. As a result of Russia's magnificent war effort, it is the custom to-day to see everything Russian through roseate spectacles, but I maintain that the establishment of collective farming in Russia caused more individual suffering and misery than has any peace-time measure in the history of the world. All of us here who know India would hate to see such drastic measures applied there, especially as equally good results can be achieved without them. A far better example has been furnished by America in the Tennessee Valley, the history of which has recently been published in the Penguin series. Its author is Mr. Lilienthal, one of the directors of the scheme. Making the fullest allowance for his natural enthusiasm, I think, after reading his book, you will find it proved that a derelict valley has been converted into something as nearly like Arcadia as human fallibility permits. What Mr. Lilienthal stresses time and again is that that has been achieved not by regimentation but by co-operation; not by dictation but by persuasion. The T. V. A. project was faced with the same difficulties as would occur in India, namely, the conflicting interests of different states. In India, they would be different provinces. There are no less than seven states affected by it, and their interests have all been reconciled. State agencies, local institutions, private organisations and individuals have been used to the full. Mr. Lilienthal admits that the results might have been more striking and spectacular had more drastic methods been adopted. But he argues, I think convincingly, that the results would not have been so lasting, and the contentment of those affected would have been infinitely less.

I am glad to think that it is the example of America rather than that of Russia that the Government of India intend following in this respect. It is a happy omen that they have been able to secure the services of one of the T. V. A. experts, Mr. Voorduin, to advise them on hydro-electric development. I hope and believe that his advice will not be confined to that aspect of the T. V. A. scheme alone, and that he will be consulted in regard to the vast possibilities opened out by the supply of hydro-electric power of which he has had so much experience in the Tennessee Valley.

DISCUSSION

Sir MALCOLM DARLING, K.C.I.E.: There are three questions which I should like to put to the lecturer. The first refers to an address which he gave about this time last year, and in which he said that 170 million acres of new land in India could be brought under cultivation. I should like to know whether he still stands by that statement because the Chairman doubted whether any substantial area could be added to India's cultivated area. No doubt in making that statement the lecturer had in mind the application of these weapons of modern science of which he has shown us slides.

My second question touches on the important question of cost. The lecturer has not indicated, I think, in any way how much it will cost to bring one acre, or say 100 acres, under cultivation with these methods.

The third question relates to the T.V.A. I was asked some months ago, by a person who once occupied a high position in India, whether a project on T.V.A. lines would be possible in any part of India. I did not know India well enough to say, but I thought that Bengal might perhaps provide a suitable area. I should like to know what the lecturer thinks.

Erosion is a subject which is very near to my heart. I remember very well, when I was Financial Commissioner in the Punjab, coming into my office one day and finding a file of huge dimensions awaiting me about erosion in the district of Hoshiarpur. On looking through it, I was struck, on the one hand, by the wealth of authority and knowledge which had been brought to bear on the

subject over a period of 30 years, and on the other hand, by the total absence of anything practical having been done. I therefore suggested to the Government that they should now make up their minds whether anything could be done, and if so, to do it, or otherwise that they should finally burn the file. They decided that something could be done, and, inspired by Dr. Gorrie, erosion operations were set going, and even before I left India in 1940 they were beginning to have an effect in the Punjab. Since then I gather that India has become much more erosion conscious.

I was particularly glad to hear from Dr. Gorrie what the Bombay Government was doing, because my last appointment in India took me to the heart of the presidency, and I was struck both by the seriousness of the problem, and by the fact that no one ever mentioned it. This year I have seen erosion at work in the lecturer's own country of Scotland, and there too nothing was being done.

This is undoubtedly a problem of the first importance for India, but one would like to have more information regarding which areas need help most. I was surprised to be told the other day by someone who had recently returned from India, that the problem applied to the whole country; if that is so, then the sooner the Government of India gets to work on it the better. It would be interesting if the lecturer could give us some assurance that that was going to be done directly after the war.

Mr. C. R. FAY, M.A., D.SC. (Reader in Economic History, University of Cambridge): I should like to thank the lecturer for his paper. I think this subject is of fundamental importance, and it is clear that it is a universal problem. It is simply a question of the correct adjustment of the proportion of soil to water; it therefore does not arise here and there, it is everywhere. There is no doubt that once this artificial process has been started in a country, the country has got to go on with it or be submerged by its own technique.

There is just one question which I should like to ask. How does the whole scheme of irrigation work in the Punjab? Where do you get your water for your hydro-electric enterprise? Is any generated from the irrigation works?

Mr. C. SWABEY (Conservator of Forests, Jamaica): Could the lecturer give us some indication of the maximum angle of slope on which it is likely that these mechanical aids can operate? The Americans talk about permanent pasture on two per cent slope, but in the West Indies we cultivate up to a 30 per cent slope. It would be interesting to know if the lecturer can give any idea of the mechanical limitations of machinery in relation to angle of slope.

Miss M. R. ROBERTSON (British Council): I should like to know whether any consideration has been given to artificial erosion, that is to say, erosion caused by war activities. I am not referring to bomb craters, but I believe that trenching has done a great deal of harm by allowing surface soil to be washed away. Is there any mechanical device which will help in this connection?

Mr. E. E. JONES (Water Pollution Research Laboratory, Department of Scientific and Industrial Research, Watford): Can the lecturer tell us something of the effects of soil erosion and the counter effects of the use of these mechanical devices, on the pollution and silting-up of rivers?

Dr. R. MACLAGAN GORRIE: The Chairman has pulled me up about my remarks on the Central Provinces. My own impression of the Central Provinces from what I have been able to see in the neighbourhood of Jubbulpore is that there is deterioration in every field. My remarks did not refer to the Berar area in which the standard is notably higher; in Berar they are well launched on a programme of tree planting in small blocks amongst their ordinary crops.

I welcome the criticism on Russia, as it gives me the chance to say that I am not a Russian "fan"; I merely staked a claim on the need for an intelligent adaptation of the experience of other countries. That experience has been obtained in some cases at a high price, and the Russians have paid particularly dearly for theirs. In fourteen years they have done what would have taken centuries to do by ordinary methods. I am as keen on the welfare of the Indian peasant as our Chairman who has so notably championed his cause. I am therefore not advocating that we adopt Russian or any other foreign methods completely, but Russia has much to teach us from her failures as well as from her successes. During these fourteen

years she has altered her lay-out for collective farming by making drastic and radical changes. In certain areas she has gone back to the old primitive type of village collectivism, which is almost feudal, while in other areas state farms have been favoured. I do not advocate rigid adhesion to either of these types, but it is up to us who have the interests of India at heart to find out what is applicable in the Russian experience.

Dr. W. C. Lowdermilk's book, *Palestine, Land of Promise* is an able exposition of what the Jews have done on collective farming in their settlements. He has proposed a Jordan Valley Authority on the lines of the T.V.A. There again, we must not accept these things completely without first sifting the good from the bad, the workable from the unworkable, as applicable to local plans in India.

With regard to Sir Malcolm Darling's question, I agree that 170 million acres is an astonishing figure for the area of "improvable" land, which I put forward at the Baroda meeting of the Crops and Soils Wing in November, 1943. I arrived at this figure by taking the following:--ten per cent of the net sown area, half of the current fallow, half of the cultivable waste, quarter of the non-available waste, and ten per cent of village forest land. Vast tracts of land which are nominally under cultivation are actually only cultivated at irregular intervals. Then there are large areas of nominal grazing land which, under present law, are exempt from cultivation; they are allocated to grazing and must not be cultivated, but they could be greatly improved by means of contouring to yield increased fodder supplies and better flood control. I still stick to my 170 million acres.

I am afraid that I can say nothing about costs for the use of military equipment. These machines are expensive to run, so I advocate their immediate use, not their permanent use. We have, of course, got cost figures for the use of civilian and agricultural mechanised equipment.

Sir MALCOLM DARLING: Is there any area in India to which the T.V.A. experiment could be applied?

Dr. R. M. GORRIE: As to what area in India are comparable with the T.V.A., I agree with Col. F. L. Brayne's interpretation, which is that the whole of India is a T.V.A. problem. There are many catchments which are simply crying out for treatment on those lines, particularly where there are enormous upper catchments under forest and the lower lands are densely populated.

As regards the hydro-electric problem, raised by Dr. Fay, that is a separate and additional reason for the complete land planning of certain areas. In the Punjab our hydro-electric supply comes from a catchment area of 150 square miles of high hills running up to 17,000 feet, and we have had a tussle over the question of what government ought to do to secure from this catchment a higher winter stream-flow by restricting grazing and indiscriminate cultivation, and introducing a higher standard of husbandry on permanent and properly terraced fields.

On the question of the maximum angle of slope on which bulldozers can be employed for making contour terraces, I think one-in-one should be quite feasible, provided that quite small bulldozers are used by determined and expert drivers. Narrow contour terraces can be made mechanically on slopes which would be considered dangerous for road building.

In the matter of artificial erosion caused by the digging of trenches, I think it will be found that where they have been dug for fighting or shelter, they are on sloping land, with the trenches also sloping. Alignment of trenches not according to the principles of contouring will certainly tend to increase erosion.

For the pollution of rivers we need not worry about the effect of trenching, because where we are doing trenching or contour bunding, the bunds themselves will look after the run-off. The run-off from properly contour-trenched land is like that obtained from rice fields, namely, a gentle trickle of comparatively clear water, as compared with the rush of mud typical of uncontoured land.

THE CHAIRMAN: I am sure the meeting will wish me to convey our very warm thanks to the lecturer for a paper which has so skilfully given interest to a technical subject. I was very glad to hear his reply to the point I made about Russia, and I am sure that we shall all agree with his attitude. We are

glad to learn lessons from whatever quarter they may be forthcoming, both in regard to what to avoid, and what to use.

I should like to congratulate the lecturer on good fortune which seldom falls to the lot of speakers in the India and Burma Section of the Royal Society of Arts. He is in a position to go back to India to put his ideas into practice, and we wish him all possible success in doing so.

On the motion of the Rev. ETHELBERT GOODCHILD a very cordial vote of thanks was accorded to the Chairman, and the meeting then terminated.

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FOREST SOCIETIES IN THE KANGRA DISTRICT

BY CHAUDHRI HARI SINGH, P.F.S.

(Divisional Forest Officer, Kangra Forest Societies Division, Punjab)

1. *Introduction.*—With a view to implement the recommendations of the Punjab Forest Commission (1937-38), a new forest division styled " the Kangra Forest Societies Division" was created in Kangra by government in April 1939 to introduce what in reality may be called a complete democracy in forest management through the agencies of co operative forest societies. The details of the constitution of this division and the progress attained, have, of late, been the subject of many inquiries which form an excuse for this article.

2. *General Conditions.*—To enable the reader to appreciate the necessity of this radical change, a short account of the economic features of the country and its forests is prefaced.

Briefly speaking the people of Kangra are peculiarly dependent upon the forests for their livelihood. They live in small hamlets (called *tikas*) widely diffused and intimately mixed with the forests. To a casual observer passing through the country, the tract appears to be thinly populated as the hamlets are so enveloped in forests. But in fact it is the most densely populated district in the province with a density of 989 persons per square mile of arable land as against an average of 460 for the whole of the Punjab. Although the people are predominantly agricultural, the agricultural holdings are too small to support them and consequently a good many eke out their livelihood in other ways preferably by taking service in the army or by pasturing of enormous flocks of sheep, goats and buffaloes. The Kangra man is not a good husbandman, keeping a greater number of cattle of a nondescript nature than his waste land and forests can support. Stall feeding is hardly known and he takes little care to neutralise the gluts and deficiencies of grass and other field forage in monsoon and winter months by silaging or by conversion into hay. The latest figures of cattle population owned by the people for agricultural, domestic and pastoral purposes reveal the existence of 459,991 bovines, 180,231 buffaloes, 7,204 horses and mules, 127,260 sheep and 234,846 goats all of which total up to the staggering figure of 1,009,532. The cattle are largely dependent for their subsistence on the scanty grazing provided by the forests and waste land impoverished by unrestricted grazing and lack of forest conservancy in the greater part of government forests. The grazing incidence over the whole area of forest and other waste comes to 1·25 heads per acre, a figure which can safely be put at 5 heads per acre if due allowance is made for inaccessible and unsuitable areas particularly in the colossal Dhaula Dhar range (15,000 ft.) whose peaks stand stern and grand in their nudity on the northern flank.

3. *The Forests and their present Management.*—The forests occupy a vast area of 808,233 acres or about 50 per cent. of the total area of the district. The history of their management since the advent of British rule in 1846, is interesting reading. Previous to the British rule, the ruler was the manorial lord of forests and other waste, and the *zamindars* were his tenants who enjoyed forest produce and grazing facilities upon the sufferance of the ruler, but not by right of possessor. But phenomenal changes took place with the advent of British rule and in the earlier settlements that followed, the ownership of land in all kinds of forests, due to certain misunderstandings, was transferred to the village proprietary body and government retained only the ownership in trees. Later on when government found it necessary to introduce forest conservancy, various difficulties were encountered and it bought certain rights from the villagers at the price of land, money and special concessions. As a result of administrative evolution extending over a long period of management, the following categories of forests came into existence :

(*i*) *Reserved Forests* (area 18,474 acres) were formed in 1872 75. As their name implies, they are the absolute property of government and are free of all rights. They are the only

class of forests in which both the soil and the trees belong to government.

(*ii*) *Demarcated and Undemarcated Protected Forests* (D.P.-187,648 acres; U.P.-400,185 acres) came into existence as a result of Anderson's Forest Settlement of 1883–97 and Gibson's Settlement of Chhota and Bara Banghal of 1901–03. Both classes of forests are protected forests within the meaning of chapter IV of the Indian Forest Act. The soil in both belongs to the people, while trees of spontaneous growth and planted by government are the property of government. The main difference between them lies in the fact that whereas appropriation of land in the former is prohibited, it is permissible in the Undemarcated Protected forests with the sanction of Deputy Commissioner.

(*iii*) *Unclassed Forests* (area 201,926 acres) were formed in 1872–75 when government constituted the reserved forests by a give-and-take negotiation of abrogating their rights of closure in the unclassed forests in consideration for the formation of reserved forests. Their land belongs to the people and trees to government, but no closures can be made without the consent of the people.

(*iv*) *Ban Muafi* (area 2,547 acres) came into being in 1863 when government acquired waste land to make it available for purchase by tea planters, and made an equivalent area from the unclassed forests in Palampur tahsil available by surrendering their rights of closures and in trees. Both the trees and land in them thus belong to the villagers and they are under the control of the Deputy Commissioner; but no closures can be made without the consent of the people.

Situated as these forests are between elevations of 1,000 ft. and 10,000 ft., they present a variety of vegetation depending on climatic, topographical and biotic influences. Amongst the distinct types may be mentioned (*i*) bamboo (*Dendrocalamus strictus*), (*ii*) scrub, (*iii*) *chir* (*iv*) *ban* oak, and (*v*) spruce and silver fir. *Chir* is economically the most important species and is the major source of income to government on account of resin which amounts to an annual output of 40,000 maunds. Unfortunately the management of these forests from its very inception did not provide for any closures except in the reserves. The result was the depletion of the forest caused by the heavy incidence of grazing by the Gaddis and Gujars to which various officers drew attention from 1901 onward from time to time. These graziers and their flocks multiplied with the time, the hillsides became bare and erosion and landslips followed. In 1919 a commission was, consequently, appointed by government consisting of Messrs. Mitchel and Walters who prepared a rotational closure scheme for certain demarcated protected and undemarcated protected forests and these forests were termed "the delimited protected forests." This scheme embraced an area of only 144,184 acres by which $\frac{1}{4}$ of the total area of each forest is closed for 30 years for regeneration of oak and *chir* forests and 10 years for scrub forests. Under the scheme an area amounting to 17,059 acres only or 2·2 per cent. of the total forest area under the control of government is closed to grazing, the majority of which is demarcated protected forest. The effect of the closure has been the insurance of regeneration and the increase in fodder for the starving cattle. This in a way shows that it is possible to include all the remaining government forests amounting to 602,111 acres, now under no regular system of management, in a general scheme for the benefit of the villagers. The grazing incidence of resident and migratory flocks exert so excessive a pressure at present on these unmanaged forests (locally and wrongly called *shamilats*) that the depletion of fertility in pastures and forests is constant. The undemarcated and unclassed forests have suffered worst and the increasing demand for forest produce has put a strain on demarcated and reserved forests which, in many cases, they are unable to stand. Nature wreaked its full revenge last year against this abuse by man when a concentrated rainfall of 25 inches in 5 hours on the heavily-grazed Dhaula Dhar, on 4th August, resulted in heavy floods dislocating traffic and destroying cultivation, bridges, roads and irrigation channels. In order to avoid further deterioration of these forests, government, in 1939, decided to enlist the co-operation of the villagers by entrusting to them the management of all government forests within each village estate, generally a *mauza**, provided they agreed to manage the

*A *mauza* (circuit) is a unit of collection of land revenue. In Kangra a *mauza* generally cosists of several *tikas* (hamlets) and occasionally of a single *tika*. The boundaries between the *mauzas* and the boundaries of *tikas* within each *mauza* are defined on land with revenue pillars.

remaining unmanaged forests under a regular working plan. The management was to be undertaken by registered co-operative societies. The formation of such societies, the preparation of their working plans and ensuring the carrying out of the provisions of the working plans by the societies, form the charge of the divisional forest officer, Kangra forest societies division and the assistant registrar, co-operative societies, of the district. The societies are being formed throughout the district with the exception of the Kulu sub-division the forest problems of which are markedly different. The present reserved, demarcated protected, undemarcated protected, delimited protected, unclassed and *ban mudfi* forests within any specific area, plus any land under private ownership which the owner may wish to entrust to the management of the society, form one economic unit to be administered as a society forest estate for the benefit of the village community. (It may be stated here that the management of forests in the Kangra distiict primarily in the interest of the local inhabitants whether right-holders or non-right-holders, is laid down in the current forest working plan of the district also as an axiom of forest management). Each society forest is managed under a regular working plan drawn up by a gazetted officer and subject to the approval of the deputy commissioner, commissioner and the chief conservator of forests. In framing the objects of this working plan, the society is consulted and the closures are so arranged as to cause the minimum hardship to the people. The prevention of erosion and denudation is the principal object of management. The cost of preparation of the working plan and original demarcation of the forest is borne by government. In the formation of societies it is essential that the consent of at least 75 per cent. of the right holders (*khewatdars* and *bartandars*) is secured. The constitution of societies is based on bye-laws sanctioned by government and before the management of the forests is entrusted to a society it is registered under the Co-operative Act II of 1912. The societies are responsible for all protection and expenditure on works required for the conservation of the forests. They appoint their own forest officers and *rakhas* who are responsible to the societies for protection. The forest officers and the *rakhas* wield powers under the Indian Forest Act to arrest offenders and seize or confiscate forest produce. From the financial point of view the societies are divided into the following two categories:

(*i*) Paying societies which get sufficient sustained income from the forest to meet their own expenditure.

(*ii*) Non-paying societies the income of which is less than the expenditure. Such societies are financed by government to meet their deficit.

In the case of paying societies, they are allowed to distribute the net profit each year amongst the members in equal shares, but they will be required to contribute to government 10 per cent. of the net profit towards the cost of the inspecting staff after five years of their existence.

4. *Conditions under which Government entrusts the Management to Societies.*—The transfer of management of government forests to the societies is subject to the following limitations:

(*i*) The government will retain its right of ownership in the land and trees, as the case may be, in accordance with the current forest and revenue settlements.

(*ii*) That government reserves to itself the right to extract resin from trees which are the property of government.

(*iii*) All income accruing to government from the forests under the management of the society shall be collected by such persons, as government may appoint, with the exception of income from the sale of trees, timber and firewood, which shall be collected by the society which will remit it into the government treasury. In these transactions the society will be bound by the rules of the Forest Account Code. Government will, subject to the vote of the Punjab Legislative Assembly, grant to the society (grant-in-aid) annually a sum equal to the amount of income collected for and on behalf of government as provided above.

(*iv*) In case of mismanagement and failure to manage the forests in accordance with the provisions of the working plan, government reserves to itself the right to terminate management by the society and restore the *status quo ante*.

5. *Functions of the Societies.*—As soon as a working plan for an organized forest society is prepared and accepted by the members, the charge of the forests is transferred from the territorial division (Kangra Forest Division) to the society. The society then becomes responsible for the management. The divisional forest officer, Kangra Forest Societies Division, acts as a technical adviser to the society in matters relating to forestry including marking of trees for sale or for right-holders. The assistant registrar is responsible for the proper maintenance of accounts by the societies in accordance with the Forest Department Code. A detailed code of procedure delineating the functions of the co-operative and forest departments in the organization and working of the societies has been drawn up and there exists a complete understanding between both as regards the functions of each. In the beginning of each year an annual plan of operations based on the working plan is prepared by the D.F.O., Kangra Forest Societies Division, for the guidance of each society and simultaneously a grant-in-aid equivalent to the estimated forest income of the year, is paid to the society to enable it to meet the running expenses. Except for the collection of crude resin and *trini* (*Gaddi* grazing dues) which is done by the territorial division, all other government revenue is realized by the societies and remitted into government treasuries. At the end of the year the excess or deficit payments are adjusted with each society after working out their total income in the Kangra Forest Societies Division. Sales upto Rs. 500 are made by the societies subject to the previous approval of the divisional forest officer, Kangra Forest Societies Division, but sales exceeding that amount are made by the D.F.O., subject to the approval of the conservator of forests in case the value of the contract exceeds Rs. 2,000.

6. *Why this Grant-in-Aid instead of letting the Societies retain the Income?*—The reader may ask when government has assigned the total revenue of forests (including resin and *trini*) to the societies, why not to let them retain it, rather than to adopt a cumbersome procedure of remitting it into treasury to be repaid in the form of grant-in-aid. Undoubtedly this was the original intention of government by creating *village forests,* but it was scored out on the ground of legal difficulties. The Indian Forest Act authorises village forests to be constituted only out of reserved forests, but the majority of the forests in the Kangra district are protected and unclassed forests. To overcome this legal difficulty, the societies and the D.F.O. of the territorial division collect all the forest revenue on behalf of government to be remitted into treasury and an equivalent amount is paid to the societies in the form of grant-in-aid.

7. *Reception of the Scheme by the Villagers.*—When the scheme was started in 1939, the people displayed marked suspicion of the intention of Government. They suspected a catch somewhere as the scheme was so benevolent in nature. Their main doubt was that Government would deprive them of their ownership of land in the forests. But this suspicion was allayed by constant propaganda by the members of the forest and co-operative departments and by the publication of a pamphlet on "Kangra Forest Societies" by Mr. Brayne, F.C.D., in 1941. Opposition, however, wherever it now exists, is mainly due to vested interests particularly of the type of unauthorised encroachment on undemarcated and unclassed forests. The orthodox mind of the old generation is another factor which comes into play, but time and constant education of public opinion and particularly of the younger generation, will alone cure it. During the first two years of the inauguration of the scheme little progress was made although this period helped a great deal in surmounting the initial legal and other difficulties. The first society was registered in November 1941 and in that year 7 societies covering an area of 4,558 acres were entrusted with management. Confidence by then was largely restored and the villagers started viewing the scheme with favour and eagerness to join the movement. Up to 1st April, 1945, 70 forest societies have been formed embracing an area of 109,809 acres, but due to the chronic shortage of gazetted staff to prepare working plans, only 40 societies having an area of 43,750 acres, have been entrusted with management. The comparative statement appended below will show the closures secured under the society management and the working plans of the district under the old regime. It will be seen that the area of the first closure under the societies, for these 40 societies, is 19,729 as against 2,481 acres of old management;

STATEMENT

No. of societies	DETAILS OF FORESTS IN ACRES—							Area under the closure scheme.	Per-manent gra-zing.	New area brou-ght under closure scheme.	1st clo-sure.	Area Closed under Mohan's W.P.
	Res-erve	D.P.	U.P.	*Ban-muafi.*	Uncl-assed.	Priva-te waste.	Total.					
1	2	3	4	5	6	7	8	9	10	11	12	13
40	1,200	16,686	17,817	178	6,448	1,421	43,750	35,763	7,987	18,754	19,729	2,481

8. *Management of Forests under the Control of Societies.*—The working plans of forest societies embody all the minute details of a major working plan prescribing shelterwood system for *chir* and oak forests, coppice for scrub and protection for badly eroded and steep forests, but a greater portionof the newly-taken up forests particularly near the habitations are allotted to the fodder and grass working circle. The responsibilities of societies, therefore, in carrying out these operations are considerable and it will be some years with all the help they are receiving from the staff of the societies division, before they can be entrusted as foresters. As was anticipated, time has eradicated the old belief of the villagers that the scheme involves a catch somewhere and confidence has been largely restored. This change in the attitude has greatly stimulated interest in protection. Unfenced closures in *chir* P. B. I. areas felled in seeding fellings only 3 years back are carpeted with seedlings in spite of their proximity to habitations. Forest offenders have little chance of escape as there are hundreds of eyes to detect them. There is a luxuriant growth of grass in the fodder and grass working circles and trees of fodder and economic value planted have gone beyond the reach of cattle in many cases. Societies which cannot utilize their full yield of grass, help their neighbouring villages to meet their demand. Government has established nine forest nurseries in the district to supply these societies and to encourage plantations in private waste. Lakhs of plants are supplied free from these nurseries and any extra demand is met by supply from the government plantations of Chichawatni and Montgomery.

Opposed to this optimism, the existence of village factions and the demand for more trees by right-holders are the two main factors to be contended with and require a careful watch by the members of the co-operative and forest departments. For the latter the by-laws and the working plans provided a sufficient safeguard, but constant education of the villagers is the only remedy for the former.

9. *The Monetary and other benefits Resulting from the Scheme.*—The forest societies scheme is one of the first of its kind to be introduced in India in which government forests are being handed over to the villagers for management and for enjoying their income. Up to the end of the year 1944-45, government has surrendered a total revenue of Rs. 83,789 to the societies entrusted with forest management. This is by no means a small amount for those *zamindars* who earn their bread with the sweat of their brow. Some of the shrewd societies have invested large profits in the national saving war certificates, some have constructed common buildings while others are raising sufficient capital to enable the whole village to pay perpetually its total land revenue out of its interest. The scheme will thus bring added income in future and more grass and fodder for their starving cattle. Their cultivation will flourish because their cattle will be better fed and their forests will improve because their management will be in their own hands. This will in its wake solve the most intricate problem of malnutrition in the district as well-bred cattle will give more milk. The soldiers returning from the army will find their forests well conditioned. They will provide them with occupation as there is ample scope to improve them still with the foreign experience and broader vision with which they will return.

The scheme is thus a boon to the district which could be planned only by a progressive and enlightened government of the type we have.

PRACTICAL HINTS ON RAISING FOREST PLANTATIONS IN VILLAGE WASTE LANDS IN THE UNITED PROVINCES

BY R. SAHAI, I.F.S.

(*Forest Development Officer, United Provinces*)

FOREWORD.—The pamphlet on "Practical Hints on raising forest plantations in Village Waste Lands in the United Provinces" was prepared at the request of the President, Court of Wards, for the guidance of the Court of Wards staff.

In view of the general applicability of the subject matter to post-war forest development in village waste lands the publication has been reproduced in the *Indian Forester*. The diagram referred to in para. 22 has not been reproduced.—Ed.

1. *Introduction.*—This short pamphlet is written to help those interested in raising fuel and fodder reserves in village waste lands in the United Provinces.

2. *United Provinces is mainly an Agricultural Province.*—Agriculture constitutes the mainstay of 90 per cent. of the population of this province. It is entirely dependent upon bullock power both for the cultivation of land and transport of produce. This is why one finds every cultivator keeps cattle. Cows produce milk which is so essential for the health of the people. Cattle produce cowdung which serves as manure for the fields, so essential to preserve the fertility of the soil.

3. *Farmer and his needs.*—For a well-balanced rural economy a farmer needs fertile fields to grow corn, fodder for his cattle, small timber, for house construction and agricultural implements, firewood for domestic consumption and cowdung manure to replenish his fields.

4. *Present condition.*—This balanced economic life has long been disturbed in the plains. Village forests which once provided small timber, firewood, and grazing grounds, have been destroyed and wastelands which supported them brought under the plough. The cultivator is forced to use his valuable cowdung as fuel and the fields are getting progressively impoverished. As the cattle remain underfed they are inefficient and more cattle are kept. Ill-nourished cows give little milk; the semi-starved bull produces weak progeny and the under-fed bullock is unable to perform work satisfactorily. So the vicious circle continues. As most of these forests and wastelands were on generally sloping grounds, erosion is also on the increase.

5. *Solution.*—The solution is to restore a balanced economy in rural areas. Every village, tahsil, and district should be self-contained with regard to its fields, grazing grounds, fuel and small timber plantations. Cowdung should be released from hearths and returned to the soil. To arrest erosion, sloping grounds and banks of streams should not be cultivated but preserved as fuel and fodder reserves. Cultivators should keep the minimum number of efficient cattle required for their use; all scrub bulls should be castrated. Cattle should be stall-fed. Enough fodder should be grown on the farms for the cattle. Green fodder should be conserved as hay or silage for use in those months when grass dies.

6. *Area of forest and grazing ground required for an average village.*—Let us consider the requirement of fuel and grazing ground for an average village, consisting of 20 families (each family consisting of five members and keeping five heads of cattle). This village will have 100 persons and 100 cattle. Hundred heads of cattle will require grazing ground of 200 acres. One hundred persons will require 500 maunds of wood fuel annually. This quantity of wood fuel can be produced by half an acre of a 20 years old *shisham* or *babul* plantation. This means that 10 acres of land under *shisham* or *babul* plantation can supply in perpetuity the demand of fuel of the village. Every year half an acre of 20 years old *shisham* or *babul* plantation will be cut down to produce 500 maunds of fuel wood and replanted to produce the same quantity after 20 years, and so on. This stage will be reached after 20 years if every year half an acre of waste land is planted with *shisham* or *babul*.

7. *Nature of waste lands in the United Provinces.*—The waste lands in the United Provinces generally consist of *usar* (saline soils), low-lying areas, sandy waste (*bhur*), ravine areas and lands declared as culturable but not actually cultivated.

8. *Usar*—*Usar* is caused by the accumulation of salts on the surface of soils and generally does not support tree growth. Most *usar* areas have an impenetrable *kankar* pan underneath at varying levels. The pan interrupts the growth of roots and throttles their progress. There are, however, certain types of mild *usar* areas where the pan is not continuous, and patches of good soil occur here and there. In these good patches, indicated by better growth of grass and often thorny species, *babul*, *dhak* can thrive.

9. By far the best use to which *usar* lands can be put is to provide grazing for domestic cattle. The Forest Department have carried out experiments for the improvement of grasses in typical *usar* areas and have come to the conclusion that if such areas are closed to grazing *during the rains* each year, the production of grass will increase by 300 to 400 per cent.

10. *Low-lying areas*—These areas are water-logged during the rains and are subject to frosts in the cold weather. They are also unfit for tree growth.

11. *Sandy areas* (*bhur*)—*Bhur* soils support *kans* grass (used for thatching) and *munj* grass (useful for thatching and strings or ropes). If these areas are closed to grazing, they get filled up by themselves with *shisham* and sometimes *nim*. *Baib* grass (used for the manufacture of paper and *ban*) also does very well on mild *bhur*. Thus these mild *bhur* areas are eminently suited for raising *shisham*, *nim*, *baib* and other suitable species.

12. *Ravine areas.*—These are areas which have become unfit for cultivation on account of the removal of the top layer of soil by the eroding action of water, usually aggravated by excessive grazing and trampling by cattle and browsing by sheep and goats, resulting in ravine formation. These are cut up by *nalas* or streams and agriculture is generally impossible. It is difficult to re-afforest these denuded areas once natural vegetation has been destroyed and the best plan is strictly to exclude grazing and browsing by cattle, sheep and goats throughout the monsoon period. Control of grazing gradually restores a natural vegetative cover, thus arresting further erosion. After a natural vegetative cover of grass and bushes has established itself, tree species may be introduced. Many ravines exhibit intercalation of *kankar* layers which impedes tree growth and it may not be possible to establish well-stocked plantations in such places. Shallow-rooted species, however, will get through here and there, while in the valleys deep alluvium will support well-grown trees and denser stocking.

13. *Culturable waste.*—Which include lands declared fit for agriculture, or, long abandoned fields, support excellent plantations. All current fallows should be reserved for food production. Old fallows and culturable wastes are best suited for forest plantations and should be taken in hand first.

14. *Common fuel species in the plains of United Provinces.*—The common fuel species in the plains of the United Provinces are:

(1) *babul*, (2) *dhak*, (3) *jamun*, (4) *nim*, (5) *shisham*.

15. Other species which could be tried in suitable localities are:

Bakain, *Bans*, *Khair*, Mesquite, *Kathal*, *Imli and Mahua.*

16. The following table shows the species suitable for the different kinds of soils:

Sandy	Saline	Moist
(1) *Shisham*	(1) *Babul*	(1) *Dhak*
(2) *Neem*	(2) *Dhak*	(2) *Jamun*
(3) Mesquite	(3) *Neem*	(3) *Babul*
(4) *Khair.*		

17. Species which will tolerate saline and sandy soils will grow also in moist localities. The overlapping is only natural. On loams all species flourish.

Methods for Raising Fuel Plantations

18. A fuel plantation involves the following operations:

(*a*) Soil preparation.
(*b*) Collection of seed.
(*c*) Sowing or planting.
(*d*) Weeding, tending, and thinning.
(*e*) Protection of the plantation from external injuries, particularly against browsing by goats and grazing by cattle.

19. In culturable soils, where agriculture is possible, the best and cheapest method of raising plants is by means of *taungya* or *bankheti*. Under this system the area is

given free of rent for cultivation to a tenant on the condition that forest species are raised along lines 10 to 15 feet apart, the intervening strips being utilised for agricultural crops. The cost of soil preparation, weeding, tending, etc. is thus eliminated as all these operations are done free of cost by the tenant in return for the rent-free agricultural crop he raises on the area between the lines. The tenant also protects the area from cattle. Agricultural crops are raised for three to five years, until the fuel trees become so high as to shade the area and make agriculture unprofitable. The only and the most serious drawback of the system lies in the tenant acquiring hereditary right in the land he cultivates. The system should, therefore, be adopted with care and not without consulting legal opinion.

20. *Soil preparation.*—The object of soil preparation is to allow the soil to weather, to make it soft and sweet to enable seedlings to send their roots easily into the sub-soil. The depth of soil working will, therefore, depend on the nature of the soil. No soil preparation is ordinarily required in *bhur* or sandy areas, as the excavated soil is blown away by wind. Thorough and deep soil preparation is almost always necessary in heavy clay soils. Soil should generally be dug to a minimum depth of 12 inches to 15 inches. The soil preparation should be started soon after the cold weather rains and finished before the end of April.

21. The following soil preparation is done under the *taungya* or *bankheti* system. Lines are laid out through the area at intervals of 12 to 15 feet. As far as possible these lines follow the contour on sloping ground to prevent them from developing into channels during the rains. The lines are dug 12 to 15 inches deep and one foot wide and the earth heaped along the lines. This earth is left exposed to the summer sun, which thoroughly aerates and sweetens it. At the end of May the earth is put back into the lines and the area is ready for sowing. At the end of each line a blank strip 5 feet wide is left to turn the plough and clod-crusher without damaging the seed lines. In water-logged areas of stiff clayey soil, lines are not dug but ridges are made as high as flood level and *jamun* sown on the ridges.

22. In areas where it is not possible to adopt the *taungya* or *bankheti* system, the most useful method is known as the *ditch-ridge*. Pits, 4 feet long, 2 feet wide, 1 foot deep, are dug along the contour, 10 feet apart, and *the earth is deposited on the downward side* to form a ridge. The ditch-ridges are in lines 10 feet apart. They are "staggered" so that water passing between ditches on the upper contour is caught in the ditch on the contour below. Just before sowing, the lower half of the ditch should be filled with earth and raised not more than 3 inches from ground level and slightly sloped on both sides. The upper half will serve as a ditch to catch rain water (*see* diagram)*, this method is particularly useful for undulating, semi-*usar*, and very dry areas.

23. *Collection of seed.*—The following table gives for the common fuel species (mentioned in paragraph 14) the months in which to collect seed, number of seeds per *seer*, and the quantity of seed in *seers* required to sow one acre of land. It is based on the assumption that 10,000 seeds are required per acre if sown in lines 15 feet apart and seed sown 4 inches apart in the line, or sown in ditch-ridges, (4 ft. by 2 ft. by 1 ft.), 10 feet apart and seed sown 1 inch apart in ditch-ridges :

Species	Month in which to collect seed	Number of seed per seer	Wastage factor	Quantity in seers required per acre	Remarks
1	2	3	4	5	6
(1) *Babul* ..	May ..	7,040	8	10	
(2) *Dhak* ..	May—June ..	1,600	6	36	
(3) *Jamun* ..	July—August ..	1,020	6	40	
(4) *Nim* ..	June—August ..	1,600	8	18	Fruit
(5) *Shisham* ..	February ..	16,000	8	5	Pods

*Not reproduced.

24. Seed of *babul*, *dhak* and *shisham* should be collected locally. Where not available it can be supplied by the Silviculturist, United Provinces, Naini Tal, if an indent is made about the end of October. *Jamun* and *neem* seed is available everywhere and should be collected locally.

25. Seed should always be collected from the tallest, straightest, and best-shaped trees in the locality. Large plump, well filled and thoroughly ripe seeds should be collected. The germination of almost all seeds is increased if soaked for 24 hours before sowing.

26. *Sowing or Planting.*—As a general rule where there are difficulties, such as swampiness, poor soil, drought, excessive weeds, grass, etc., planting is more likely to be successful than sowing. Some species such as *babul*, and *dhak* must be sown, for neither of these species will succeed if transplanted. On the other hand the best method for raising *shisham* and *jamun* is by planting root-shoot cuttings (made from two years old plants, of the thickness of a thumb, by keeping 1 inch of stem, and 9 inches of main root). *Neem* and *shisham* are as easily sown as transplanted. The initial cost of planting is almost always greater than that of sowing. The subsequent costs of replacements and weeding are less for the former than for the latter.

27. Sowings are generally made at the break of the rains or if made earlier, will not germinate till then. Growth of shoot and more particularly root development, practically ceases by October. So, if a plant is able to send its root down to a depth say of about a foot or more before growth ceases in October, it will be able to survive the hot weather, otherwise it might die of drought in hot weather.

28. On ridges seed should be sown about one inch apart. It should be sown about 1 inch deep and lightly covered with earth to prevent it being washed away by rain.

29. *Entire transplants.*—The best size for entire transplants is when the root is 6 to 9 inches long, and the stem has two or three leaves. For purposes of transplanting it is advisable to keep a little earth round the roots and to pack the plants carefully into baskets. It is often better to chip off the existing leaves before transplanting.

30. *Root and Shoot cuttings.*—Root and shoot cuttings are best made from healthy seedlings varying in thickness of the thumb to a finger. The root should be clean cut down to 9 inches in length and the stem to 1 inch. Side roots should be cut to about an inch from where they join the main root. These stumps should be packed in earth paste and covered with wet straw, and transported to where they are required.

31. *Season of sowing or planting.*—If irrigation is available, sowing and planting should be done early in March. If irrigation is not available all transplants should be put out after the rains have set in. Planting must be completed rapidly, and within a fortnight of the break of rains. Sowings must be done after the first smart shower.

32. *Weeding.*—After the planting or sowing has been done every effort should be made to expedite their development. The best way to ensure this is thorough weeding and soil working during the first rains. The object of weeding is to eliminate competitors for available nourishment. Weeding must be done carefully. Weeding should only be done when the soil is sufficiently dry so that it does not stick to the roots. Soil working should be done at the same time as the weeding, softening the upper soil layers. Efficient soil working around young plants is at least as important for preserving moisture as weeding.

33. Usually no weedings are required for a month after sowing. By the end of July grass springs up among the seedlings, and *should be plucked by hand, no khurpi or other sharp instruments likely to damage young seedlings should be allowed.* By the end of August a second weeding is necessary, but this time, as the plants are stronger, it is done with a *khurpi* and the soil is loosened in addition to removing the grass. The third and final weeding for the season is done about the end of September, when the rains are over. No weeding or loosening of the soil is done in the cold weather. Two weedings are generally required in the following rains.

34. *Injuries to which plantations are liable and methods of protection.*—Goats, sheep, domestic cattle, deer, and *nilgai* do considerable damage to plantations. Cattle are very fond of eating tender *shisham* leaves, while *browsing by goats is an especially serious menace.*

35. Under the *taungya* or *bankheti* system the cultivators should make a ditch

all round the plantation. The ditch should be 4 feet deep and 3 feet wide at the top and 2 feet at the bottom. The excavated earth is heaped on the inside to form a ridge giving further rise of 2 feet above the ditch. A live thorn fence along the ridge is a great advantage.

36. *Tending and thinning.*—The amount of tending necessary depends on the rate of growth of the species selected. Very little tending is necessary with fast growing species under *taungya* conditions. The object of tending is to provide adequate room for the growth of each plant. In attaining this object the best and most promising plants are retained while those which are crooked and sickly are removed. The undergrowth, not actually interfering with the plants, should be allowed to come up—thus forming an understorey which will help to cover the soil. The plants should be so spaced that their crowns do not touch one another.

37. Thinnings are mostly concerned with the removal of :

(*a*) diseased, dead, and dying trees;
(*b*) trees which are being left behind in the struggle for existence;
(*c*) misshapen trees or trees with poorly developed boles or crowns;
(*d*) trees with good crowns and boles which are harming more valuable trees.

38. Thinnings become necessary in a plantation of fast growing trees when the trees are big enough to form a crown. This occurs when the plantation is five years old.

Forest Pool

By BEVERLEY GITHENS

I know a little hidden forest pool,
All jade and onyx, where the mountain spills
Along a tiny watercourse a cool
And constant stream. The creatures of the hills
All know this place, rock-sheltered from the sun;
The little foxes, rabbits, squirrels, birds
All know this covert where pure waters run,
All understand the lovely singing words
Hill waters use. The ugly or uncouth
Could not find satisfaction, or thirst, there.
One leaf, at night one star—the things of truth.
Hushed, small, and lonely—these are mirrored where
Such waters flow . . . where we have understood
The gift of water . . . and that thirst was good!

23rd March, 1945. *Christian Science Monitor.*

MY IMPRESSIONS ON THE GENERAL PRINCIPLES OF TEAK PLANTATION

BY P. M. TAGGARSE

(*Forest Depot Officer, Dandeli, Kanara Northern Division, Bombay.*)

The article published in the February 1945 issue of the *Indian Forester* on "Teak plantations in Mysore and their site quality" by Dr. Krishnaswamy Kadambi, D.Sc., is an interesting one. My experience in teak plantations for quite a number of years in Kulgi range, Kanara northern division, province of Bombay, impels me to comment upon the general principles of teak plantation technique.

The life of a teak plantation in the first ten years of its existence is almost the same in all places. Raising it from stumps with the advent of premonsoon showers and the intensity of weeding and cleaning operations done might vary to a certain extent but the fundamental principles remain the same. It is in this period that the plantation is made or marred. The fall off in growth or otherwise then depends more on the quality of the soil, level of the water table that exists in that particular locality, atmospheric agencies such as frost, and lastly defoliation which during the last two decades has been on an increase everywhere. Where teak plantations are raised on extensive areas continuously year after year, I am of the firm belief that the water table does definitely fall off. That is why in 'pockets' we always find better growth than on other areas in the same plantation. Further if the areas are of subsoils not capable of maintaining a high water table the rate of height growth is sure to fall. This points to the conclusion that it is these two factors *viz.*, the nature of subsoil and the water table, which mainly govern height growth in the infancy of a plantation and also thereafter.

With the raising of a pure teak plantation the demand on a particular food substance in the soil is bound to be more. This is bound to diminish the quality of the soil to a great extent and as the life span of teak is nearly a hundred years it can be well imagined what it would mean for the site quality of the soil after the first rotation of the plantation. Since our aim is always to have a maximum yield per acre of teak, the encouragement of other miscellaneous species, as either associates or as understorey, to any appreciable extent has to be discouraged. If such associates are allowed on a larger proportion there is fear of struggle for existence and consequent retardation of the growth of our main crop. In agriculture it is seen that in the same area no two crops are grown mixed together but in the same area two crops are grown in alternate years. Wheat may be grown the first year and cotton the next. This is said to maintain the general quality of the soil. If this principle is made applicable to forestry, crops of different species will have to be grown alternately in successive rotations. What would be required in a pure teak plantation is an understorey just sufficient to prevent loss of soil by erosion and fall in the water table by excessive run off of rain water. Deterioration of soil is certain to take place in a plantation with a good stocking of teak. And in my opinion this can only be eliminated in the second rotation of the area by growing a different crop that would replenish the lost chemical properties of the soil.

The large area of natural forest clear felled, burnt and then laid bare to the sun, wind and rain for a few years of the life of the plantation is sure to have cumulative effect on the soil being washed away and early soil erosion must be having a great effect on the soil which the plant food devouring teak crop is not in a position to give back by way of its poor leaf mould humus.

Defoliation has certainly a bad effect on the growth of a teak plantation especially in seasons of severe defoliation which usually starts rather early in the monsoon after a long spell of drought. In years of very bad defoliation I have noticed the leading shoots killed to an extent of one or two feet which causes the plants to send out two leaders. This naturally stunts the height growth. The present control measures of leaving broad strips of natural forest in between teak plantations has little or no effect. The use of any germicidals on an extensive scale will also be of no avail unless of course unlimited expenditure is incurred which in case of plantations, meant to give financial results, is never permissible.

The problem that may confront us in the regeneration of pure teak plantations will not

be, in my opinion, the availability of the adequate burning material after the first rotation. The use of the nitrogenous substance mainly by the teak crop and the consequent impoverishment of the soil may not permit a good teak crop in the second rotation. And, in this case, as I have said before, planting up the area with a different species will be necessary.

Teak grown in plantations has naturally a quicker growth and the formation of heartwood is not so fast as that of natural teak. I opine that if heartwood is formed early in teak plantations the future of such is not in any way promising, as it would be certain that there is some factor responsible in the setback of growth. This must be either due to the bad site or the struggle for existence has set in. The first cause can be well eliminated by avoiding areas which dry up too soon and controlled by leaving broad belts of natural vegetation at regular intervals along the contours of the area. The second one can be overcome by proper and timely thinnings. In the first two thinnings in plantations of Kanara northern division, heartwood is hardly found, which therefore does not give a ready market for the thinned poles.

Formation of epicormic branches has been attributed mostly to opening up of the canopy. I have noticed such branchiness in trees found on flat areas or in areas where a definite hard subsoil is noticeable. Whilst the opening up has been responsible for such epicormic branches, the site quality has much to do with this drawback.

Treatment of teak plantation must vary according to different localities. No hard and fast rules can be ever laid down in the silviculture of teak plantations. But the basic principles of tendings and thinnings cannot be ignored. In teak plantations it is a question of "maximum benefit with minimum investment" and therefore original espacement, early tendings and periodical thinnings have to be done giving due regard to the financial aspect. The problem that would always baffle a forester in the raising of teak plantations will be to decide the vital issue of "revenue and expenditure!"

Many of the opinions expressed in this interesting article are contrary to general opinion and experience and readers are referred to *Indian Forest Records* (Silviculture) Vol. V, Nos. 1 and 2. "The problem of the pure teak plantation" and "Teak plantation technique" for other views. These differences of opinion about teak plantation work usually arise in the poorer areas (not really suitable for teak) where teak is grown because even the poorest teak is more valuable than the best of other species. There are really two subjects (1) the problem (if any) of the pure teak plantation and (2) the growing of teak on poor areas. These two subjects are often confused.—*Hon. Ed.*

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EFFECT OF DIAMETER OF TEAK STUMP ON SURVIVAL PERCENTAGE AND EARLY HEIGHT GROWTH.

(Hoshangabad division, Central Provinces, Bori special teak working circle).

The central silviculturist has sent us the following account of two experiments carried out in the Bori forests by the district forest officer, Hoshangabad on the effect of the diameter of teak stumps on survival percentage and height growth.

The experiments are of interest in that they confirm the results of the original experiments in Madras.

Stumps of over half an inch in diameter show an increased survival percentage of 15 to 50 per cent. and an increased height growth of over 100 per cent. compared with stumps of smaller diameter. Such a result is very striking and very important in the early competition of a plantation against weeds.

Hon. Ed.

1943 EXPERIMENT

This experiment was carried out in compartment 14, Bori, and its first year's results were published in the *Indian Forester* for March 1944 pages 79 and 80. The second year's measurements were taken on November 3rd, 1944 and are given below together with the first year's measurements for comparison.

Treatment letter	Size of stump in inches	Survival Percent.		Mean height growth in inches.	
		1943	1944	1943	1944
A ..	0.3—0.4	79	76	5.2	29.0
B ..	0.4 - 0.5	86	82	7.5	38.4
C ..	0.5—0.6	84	81	9.5	45.7
D ..	0.6 0.7	93	89	11.1	50.3
E ..	0.7—0.8	95	91	12.5	50.2

In survival percentage there are no great variations as casualties during the second year have been generally either three or four per cent.

As regards height growth, the following table shows the analysis of variance :—

Variation due to	S.S.	D.F.	Variance	F.
Replications..	189.89	3	63.297	..
Treatments ..	1,318.91	4	329.728	9.66
Error ..	409.73	12	34.144	..

The differences in height growth due to the diameter classes of stumps used are thus very highly significant. The standard error for the difference between means is

$$\sqrt{\frac{34.144}{4}} \times 2 = \sqrt{17.072} = \pm 4.132.$$

The critical differences at the 5 per cent and 1 per cent. levels are thus 9.00 and 12.62 respectively.

The average heights of the plants per treatment are 29.0 in. (A); 38.4 in. (B); 45.7 in. (C); 50.3 in. (D) and 50.2 in. (E). Thus D and E are significantly superior to A and B; C is significantly superior to A only.

It is interesting to note that at the end of the first growing season C was significantly superior to B, and D and E were superior to C.

The striking effect of the diameter of the stump on the resulting height growth has therefore started to decline although it is still very marked. The experiment should continue to be kept under observation for two or three more growing seasons until the significant differences disappear or until the first thinning whichever is earlier. Measurements of course should be made each year.

1944 EXPERIMENT

Locality.—Compartments Nos. 26 and 27, Bori special teak working circle, Hoshangabad division, C. P.

Area.—0.4 acre.

Layout.—20 plots each of 6×4 stakes at 6 ft. × 6 ft. spacing, arranged as follows, *i.e.*,

four replications of five treatments.

C	B	A	E
B	A	E	D
A	E	D	C
E	D	C	B
D	C	B	A

Stock used.—One year old plants raised in the nursery at Hiranchapra from weathered Bori teak seed.

Treatments. A stumps 0.3-0.4 in. in diameter.
B stumps 0.4-0.5 in. in diameter.
C stumps 0.5-0.6 in. in diameter.
D stumps 0.6-0.7 in. in diameter.
E stumps 0.7-0.8 in. in diameter.

Date of planting.—19th June 1944.

Measurements.—The plants were enumerated and their heights recorded on the 23rd February 1945.

Results.—Measurements on the above date, at the end of the first growing season showed :

Treatment	Size of stump	Survival per cent.	Mean height growth
	Inches		Inches
A ..	0.3—0.4	50	6.4
B ..	0.4—0.5	76	7.2
C ..	0.5—0.6	91	10.2
D ..	0.6—0.7	90	12.2
E ..	0.7—0.8	88	13.2

The data were analysed statistically with the following results :—

I Survival percentage

Analysis of variance

Variation due to	Sum of squares (S.S.)	Degrees of freedom (D.F.)	Variance	F
Replications..	42.6	3	14.20	..
Treatments ..	269.3	4	67.33	22.52
Error ..	35.9	12	2.99	

The value of F for 1 per cent. probability is 9.6. The differences due to the diameters of the stumps are thus very highly significant. The position of the individual diameters of stumps is analysed below.

The standard error for the difference between means is $\sqrt{\frac{2.99}{4} \times 2} = \sqrt{1.495} = \pm 1.223$. "t" at 5 per cent. and at 1 per cent. is 2.179 and 3.055 respectively, the corresponding critical differences being 2.66 and 3.74.

The average number of survivals per treatment is 12.0(A); 18.3(B); 21.8(C); 21.5(D) and 21.0(E). C, D and E are thus each significantly superior to A and B at the 1 per cent and the 5 per cent levels respectively.

II Mean height

Analysis of variance

Variation due to	Sum of squares (S.S.)	Degrees of freedom (D.F.)	Variance	F.
Replications ..	5.57	3	1.857	
Treatments ..	167.69	4	41.923	29.46
Error ..	17.08	12	1.423	

The differences due to treatments are again very highly significant. The standard error for the difference between means is $\sqrt{\frac{1.423}{4} \times 2} = \sqrt{0.7115} = \pm 0.844$ and the critical differences at the 5 per cent. and 1 per cent. levels are 1.84 and 2.58 respectively.

The average heights of the plants per treatment are 6.3 in. (A); 7.2 in. (B); 10.2 in. (C); 12.2 in. (D) and 13.2 in. (E). C, D and E are thus all significantly superior to A and B at the 1 per cent. level, but D is superior to C also at the 5 per cent. and E to C at the 1 per cent. level.

Discussion

C, D and E are very superior to A and B both in respect of survivals and height growth. This is confirmed by combining the figures in the pattern adopted by the international union of forest research organisations, Sweden, as follows :—

Treatment	Percentage of good plants to living plants	Height in inches	Height × % of good plants
A ..	27.0	10.1	272.70
B ..	30.1	11.1	334.11
C ..	78.2	11.5	899.30
D ..	86.0	13.2	1,135.20
E ..	96.4	13.5	1,301.40
	Mean	..	788.54±208.35.

Note.—The convention is that a "*good*" plant is one the height growth of which exceeds the mean less its standard deviation. In this instance the general mean is 10.3 in. and the standard deviation 3.8, giving us 6.5 or say 7 inches as the critical value. All plants over 7 inches in height were thus taken to be good plants.

In Bori one of the main difficulties is to get stumps big enough for planting in one year. The main practical data, therefore, concern the smaller sizes rather than the larger sizes.

The above results clearly demonstrate that as far as the end of the first growing season the plants raised from stumps of 0.3 to 0.4 give a significantly very inferior survival percentage and height growth when compared with stumps of size classes from 0.4 to 0.8 inch diameter.

Conclusions

The experiments are only the first two in a new locality and need confirmation by repetition. They do however give a definite indication that under Bori conditions it is not worth while to use stumps as small as 0.3 to 0.4 inch diameter and better not to use those of 0.4 to 0.5 inch diameter if larger sizes are available.

Note.—This is interesting confirmation of results obtained in Madras and published in *Indian Forest Records* (New Series) Silviculture Vol. 3, No. 5 (1938). It appears that the effect of diameter of stump is even more pronounced under Bori diameter conditions than under Madras conditions.

UNIRRIGATED CANAL PLANTATIONS IN THE UNITED PROVINCES*

By K. D. Joshi, I.F.S.

(*Divisional Forest Officer, Afforestation Division, U. P.*)

FOREWORD.—The Forest Department, U.P. manages on behalf of the Irrigation Department a total area of 24,263 acres of canal bank plantations. Of this, 18,011 acres is in the charge of the afforestation division, U.P., while the balance is managed by the Saharanpur forest division of the western circle, U.P. The oldest canal plantations created by the forest department are now 15 years of age and are doing very well on the whole wherever the soil and the terrain are suitable. In heavier *usar* tracts of high soil salinity, the growth is inevitably poorer, but it can be stated definitely that results are generally favourable and these plantations will provivde valuable resources of timber, fuel, fodder and pasturage for local needs. Up to 1944, a total area of about 11,000 acres has been planted up under regular working schemes. In the following article Mr. K. D. Joshi provides an interesting description of the working in his division.

E. W. RAYNOR,
Conservator of Forests,
Working Plans Circle, U.P.

Canal plantations have been in existence along both banks of the Main and Lower Ganges Canal systems ever since the construction of these canals in the early fifties and seventies of the last century. These plantations start from Hardwar, the head of the Main Ganges Canal and from Narora the head of the Lower Ganges Canal extending right down to the tail of the system in the Fatehpur Canal which extends to the Allahabad district. In addition, the Lower Jumna Canal system with its head-works at Okhla near Delhi and extending below Agra, is also included in the scheme of the afforestation division, U. P.

The aggregate area covered by unirrigated canal plantations managed by the Forest Department, U.P., is distributed in the various canal divisions as shewn below:

		Ganges Canal (Main and Lower) Acres
Bulandshahr Canal Division	..	1,614.86
Aligarh Canal Division	..	2,338.00
Mainpuri Canal Division	..	4,617.24
Narora Canal Division	..	2,026.42
Etawah Canal Division	..	2,145.78
Cawnpore Canal Division	..	2,216.94
Fatehpur Canal Division	..	Less than 50 acres
Upper Agra Canal Division	..	1,984.85 acres Lower Jumna Canal
Lower Agra Canal Division	..	1,435.28 acres. do.
Total	..	18,400 acres approximately.

The principal species in the plantations are mainly *sissoo* (*Dalbergia sissoo*), and *babul* (*Acacia arabica*) with occasional teak, *jamun*

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*Paper presented at the 6th Silvicultural Conference, Dehra Dun, 1945, on item 6—The Afforestation of Dry and Desert Areas: Communicated by the Conservator of Forests, Working Plans Circle, United Provinces.

(*Eugenia jambolana*), *nim* (*Azadirachta indica*), mangoes and other species interspersed along both the banks. The strips available for planting on either bank of the canals are narrow, varying in width from one-fifth of a chain to five chains and the plantations are therefore linear in type with very little breadth. Towards the tail of every canal, the strips become very narrow and incapable of growing more than one line of trees, which is maintained as a shade-line.

Soil.—Extending as these plantations do from Hardwar on the north-west to near Allahabad in the south-east, the soil necessarily varies from district to district. The soil type can be distinguished as *bhur* (sandy loam), *domat* (loamy), clayey, stiff clay, *usar* (alkaline) and *kankar* (calcareous nodules), from place to place. There is no one stretch on any particular type of soil over any considerable length but the type varies from place to place, although to the north of the system towards Bulandshahr, better soil prevails. *Usar* soil prevails in the lower parts of Aligarh, Etah, Etawah and Cawnpore districts. The Bhognipur Branch in Etawah district is almost entirely on sandy loam throughout and bears the best growth of *sissoo* in the division, having practically no *usar* soil.

Climate and Rainfall.—The climate is typical of the plains with a hot *loo* or westerly wind blowing in summer, and a definitely cold period in winter. The annual rainfall which varies from 28″ to about 30″ from district to district, has a considerable influence on the growth of trees along the banks of the canal system. The main bulk of the precipitation, (about 90″) falls in the rains from June to the middle of September. Frost damage is quite common, but its intensity varies from district to district.

Damage.—The plantations are exposed to serious damage caused by illicit lopping, felling and heavy grazing, owing to the narrow strip of land on canal banks being unfenced and at the mercy of the neighbouring villagers and their cattle.

Composition and condition of the existing crop (*i.e. of the crop which originates from the inception of the canal system*).—The plantations towards the north of the system exhibit better growth but in the centre and towards the tail of the system they have suffered heavily from heavy fellings in the past combined with damage caused by villagers who have only the canal plantations to fall back upon for their legitimate or illegitimate demands. There are however occasional good stretches of well grown *sissoo*, *jamun*, *nim*, *babul* and mangoes. On the whole the crops are poor, the average density being less than 0.2 on the average.

Afforestation. The whole canal system subsequently came under the management of the forest department at different periods and has now been brought under regular working plans. The first working schemes were prepared in 1931-32 and 1932-33 for the ensuing ten years. These schemes have been revised recently resulting in continuity of working. Due to the war and consequent shortage of officers, the working schemes for the Bulandshahr, Aligarh, Upper and Lower Jumna canal divisions could not be revised but interim felling schemes have been prepared to ensure continuity.

Regeneration.—The system followed is clear-felling (except for the reservation of two shade-line trees per furlong) with artificial regeneration along both banks of the canal system. As soon as fellings are completed, the felling areas are cleared of all thorns, weeds and grasses which are then burnt in summer before commencing soil preparation. Trees are always uprooted and no stumps are allowed to remain.

Soil preparation.—Soil preparation is carried out after March or April as soon as fellings have been finished and continues up to the break of rains in June. After burning of slash, the dry hard soil is loosened. Pits are dug $2' \times 2' \times 2'$ at an espacement of 20′ along the edge of the plantation adjoining the canal bank roads at a standard distance of 25′ from the *daula* or raised bank of the canal. These are for the shade-line trees. In the rest of the felled area, ridges are made 5′ long by 2′ wide by 18″ deep, at an espacement of 10′ from centre to centre, in lines 10′ apart. When banking up the earth on these ridges, care is taken to leave a depression to catch rain-water above each ridge, one side of which is raised to receive the seed, which is sown on two rows, one along the base and the other along the top of each ridge. Along swamps or flooded areas raised mounds are made sufficiently high to keep their tops at least 9″—12″ above the highest flood level, in order to avoid dying back due to swampiness during the rains. The ridges in one line alternate

with those in another, *i.e.* they are staggered. In order to provide export in later years strips 12′ wide are left through the plantation areas especially along the left bank service road. The pits intended for planting with cuttings along the shade-line are made 20′ apart, with intervening ridges for ordinary sowings. No preparation of soil is done in places where root suckers are expected as a result of the uprooting of *sissoo* trees in the course of fellings. No work is attempted in heavy *usar* soils.

Choice of Species.—(*i*) In *bhur* (sandy) areas, stumps and transplants do best and here *sissoo* is generally preferred. *Babul* sowings also thrive in such soils.

(*ii*) In clayey soils, *babul* and *jamun* sowings or transplants do best.

(*iii*) In *dumats* (loams) *sissoo* sowings, stumps or transplants, *babul* or *khair* (*Acacia catechu*) sowings, *Jamun* transplants or sowings, *siris* (*Albizzia* spp.) stumps or sowings, mango transplants and bamboo rhizomes are found to thrive.

(*iv*) In water-logged areas, *jamun* transplants do tolerably well. *Kanju* (*Holoptelea integrifolia*) sowings also do well.

(*v*) Permanently water-logged areas are rare, but *jamun* sowings or transplants on raised mounds do best, provided that the initial sowings or plantings are done above water level.

(*vi*) In *usar* areas, (except heavy *usar*) in which no work is attempted, *nim*, *imli* (*Tamarindus indica*) or *siris* cuttings or transplants do best.

The areas carrying different types of soils are distinguished by the working plan officers when allocating them to the Timber and Fuel working circles. In timber working circles *sisoo* is grown from sowings, stumps or transplants, while mango, *jamun*, *imli* and *siris* are propagated by entire transplants. In fuel working circles, *babul* is usually raised by sowings with some admixture of *Khair*.

Sowings.—The following species are sown :—

Sissoo, *babul*, *khair*, *jamun* and *nim*. All sowings are completed by the middle of June before the break of the monsoon although temporary cessations of the monsoon for long periods necessitate resowings. This sometimes happens twice or thrice in the season.

Planting.—*Sissoo* stumps are raised very successfully in nurseries that are dispersed throughout the entire canal system. Transplants of mangoes, *jamun*, *nim*, *imli* and *siris* are utilised according to the type of soil. All planting is completed before 15th July each year.

Root-suckers.—When the root of a *sissoo* tree is dug out the wound stimulus caused by the cutting of the lateral roots results in their sending out root-suckers all round the parent felled tree, sometimes up to a distance of 20 yards. The root-suckers at the end of the rains often reach a height of 7′ or more on good soils, while on poorer soils the height growth is between 3′ and 4′.

Shade-line.—This is planted at a distance of 25′ from the toe of the *daula* (raised bank) of the canals. The species selected are *sissoo*, mangoes, *jamun*, *imli* and *nim*, although preference is given to *sissoo* and mangoes. In bad soils, *nim*, *imli* and *siris* are preferred, although *nim* is avoided, since it is badly lopped by villagers.

Weeding and Hoeing.—Three weedings are always done, the first at the end of July, the second in August and the third in the last week of September or the first week of October. While weedings are in progress, the soil is thoroughly loosened and weeds removed. Some spacing of plants is done in the first and second weedings but in the third or final weeding, adequate spacing out of plants is done on the ridges. Generally plants are left 1′-2′ apart depending on the height growth attained by that time.

Spacing of Root-suckers.—In areas where *sissoo* root-suckers occur, they come up so profusely that a spacing out is always necessary. This is done at the third weeding. Suckers are spaced 3′- 6′ apart, according to the height growth and the vigour of stems thinned.

Nurseries.—Wherever flow irrigation is available nurseries are sited along the canals at suitable intervals for raising adequate supplies of plants for the afforestation work. Plants raised are *sissoo*, mangoes, *jamun*, *imli*, *nim*, bamboos and *siris*.

Rates for Works.- The costs of sowing, preparation of soil etc. prevailing in the division before the present war are given below :—

(*i*) Clearing of site, including burning ;
As. 8 to Rs. 2 per acre.

(*ii*) Soil preparation :—

(*a*) Ploughing flat or undulating ground, Rs. 4 to Rs. 5 per acre ; rarely done.

(*b*) Making ridges 10′ apart (5′×2′ ×12″—18″ deep), Rs. 5 to Rs. 6 per acre.

(*c*) Ditch ridges (5′×2′×1′) 10′ apart, Rs. 6 to Rs. 7 per acre.

(*d*) Pits 4′×4′×4′ (40′ apart), Rs. 3-6 per acre in gardens.

3′×3′×3′ (20 apart), Rs. 6 to Rs. 7 per acre in gardens.

Pits 2′×2′×2′ (15′ apart), Rs. 4 per acre.

$1\frac{1}{2}'\times1\frac{1}{2}'\times1\frac{1}{2}'$ (10′ apart), Rs. 6 to Rs. 7 per acre.

(*iii*) Sowings, As. 8 to As. 12 per acre.

(*iv*) Plantings, Rs. 2 per acre.

Filling up of gaps in later years, Re. 1 per acre.

(*v*) *Tending.*

(*a*) Fencing with thorns As. 8 to As. 12 per acre.

(*b*) Fencing with earth enclosures As. 12 to Re. 1 each.

(*c*) First weeding, Rs. 2 to Rs. 3 per acre. Second weeding, Re. 1-8 to Rs. 2 per acre.

Third weeding including spacing of root-suckers, per acre Re. 1 to Re. 1-8.

Average rates of growth for sowings on loamy soils are as under :—

Growing seasons	TOTAL HEIGHT IN FEET				BREAST HEIGHT DIAMETERS IN INCHES			
	Sissoo	*Khair*	*Babul*	*Jamun*	*Sissoo*	*Khair*	*Babul*	*Jamun*
1 ..	6	6	6	3				
2 ..	12	12½	12	6	1.5	1.5	1.5	0.6
3 ..	18	19½	18	9½	2.5	2.5	2.5	1.6
4 ..	23½	6	22½	15	3.5	3.5	3.5	2.8
5 ..	29	33	28	22	4.5	4.6	4.5	4.0
6 ..	34	7	32	30	5.6	7	5.6	5.3

Taungya.—Plantations by the method known as *taungya* or *bankheti* are not attempted in canal areas but in a few places where mango plants are raised, the intervening space is let out for cultivation to ensure adequate weedings and regular irrigation.

Gardens.—These have already been mentioned under irrigated plantations, but a few further remarks here will not be out of place. The existing gardens handed over to us by the canal department are all maintained and kept in order. In order to eradicate weed growth which is found detrimental to the growth of fruit trees, the land is let out for cultivation. This cultivation not only ensures proper eradication of all weeds, (especially of *Imperata* which is most injurious) but the supply of water to the trees is also assured. The cultivators keep the plants thoroughly hoed and watered throughout. As a concession they receive free supplies of water from the canal department.

Thinnings.—The first thinning is done following the third growing season, the second following the sixth growing season and the third following the tenth growing season. In the fuel working circles where the rotation aimed at is 15 years, no further thinning is done but in the timber working circle a fourth thinning is suggested at the end of the fifteenth growing season and a fifth at the end of the 25th growing season. During the conversion period, a rotation of 40 years has been adopted for timber working circles and this is considered enough to meet present necessities. Cutting of climbers is done at the time of thinnings, although these are not very serious pest.

Spacing of trees after thinnings.—The spacing of plants aimed at after first thinning at the

end of the 3rd growing season is $5' \times 12'$ on an average.

After 2nd thinning at the end of the 6th growing season is $10' \times 12'$ on an average.

After 3rd thinning at the end of the 10th growing season is $15' \times 18'$ on an average.

After 4th thinning at the end of the 15th growing season is $18' \times 24'$ on an average.

After 5th thinning at the end of the 25th growing season is $24' \times 30'$ on an average and so on.

Revenue Realised.—The distribution of areas by districts is recorded above under paragraph 2. The total acreage is 18,400 acres and the average revenue realised annually amounts to Rs. 2,73,310 or Rs. 14-15-0 per acre. The average annual expenditure amounts to Rs. 1,06,025 or Rs. 5-12-0 per acre, leaving a net revenue of Rs. 1,67,285 or Rs. 9-3-0 per acre. The net revenue is shared between the forest and canal departments on a sliding scale.

"SEEDING FELLING".

By R. O. Drummond, M.B.E., I.F.S.

(Deputy Conservator of Forests, West Almora Division, U.P.)

In working plans for *chir* (*Pinus longifolia*) in the United Provinces, and very possibly in other parts of India and for other species also, the term "Seeding Felling" has come to have two distinct meanings.

These two meanings will, I hope, become clear if I describe the method of marking in force when the first regeneration operations are to be undertaken in a *chir* area.

On starting markings, the crop present in the area can and must be divided into two categories :—

A. Young healthy crop, from sapling to pole crop stages, which is sufficiently dense, young and healthy, and present over a big enough area to be accepted as future crop without further recruitment.

B. Old crop, from immature to overmature stages, which is too old, open or unhealthy to be accepted for future crop, and which must therefore be regenerated *de novo*.

In crops of type A, the remnants of the old crop from which the young crop originated may have already disappeared, or they may still remain. If they remain, they are marked for felling in what is really a "final felling" of that part of the forest concerned.

In crops of type B, seed-bearers are selected at the proper espacement, reserved as such, and the rest of the crop is marked for felling.

Now, the two uses and meanings of the term "seeding felling" at present are :—

(*i*) To denote the felling of areas which contain both types of marking as described above. In other words, the term is used as a synonym for "the first regeneration felling in a regeneration area."

(*ii*) To denote the felling of an area of type B only.

In my opinion it is correct to use the term "seeding felling" only in the second sense. To use it also in the first sense, as a synonym for "the first regeneration felling" is not only a loose and improper use of the term, but is also confusing to subordinates and in our records.

In a further attempt to prove my point, let us take an extreme case—and I hasten to add that this example is by no means so far-fetched as it may sound, as there are areas in this division where forest of the type now to be described as an extreme case do actually exist.

Let us, then, assume that an area has been found, which has been allotted to P. B. I. for regeneration, in which the main crop has become very open as a result of heavy casualties in the past. Due to the open spacing of the crop, let us further assume that conditions have permitted the appearance of advance growth of regeneration of sapling to pole stages. The marking officer will therefore find that the greater part of the area already contains regeneration acceptable as future crop, and will proceed to mark the area for what will be in fact a final felling. Only in the small area which has not got advance growth already present will he reserve seed-bearers and do what can be legitimately called a marking for "seeding felling". Yet, under the present practice, the felling of this area as a whole will be called a "seeding felling" and it will be entered as such in the records. Surely this cannot be right ?

The working plan appears to realise the anomaly, as the term "mixed seeding and

final felling" has been introduced, and this has given rise to a most objectionable term "mixed felling" much used by subordinates. I say objectionable advisedly, as it has led to confused thinking in marking, so that, in middle-aged crops, a marking which is a sort of hybrid between real seeding and real final felling marking, is done, which is quite wrong silviculturally. But the use of these terms does, I think, clearly show that both the working plan and divisional staff have all felt that the use of the term "seeding felling" to include big areas of "final felling," simply because it was the first regeneration felling, was wrong, and misleading.

I am therefore strongly in favour of abandoning the use of the term "seeding felling" except to denote the fellings in an area where seed bearers have been retained and regeneration *de novo* is required, and I suggest that some such term as "primary felling" should be used to denote the first regeneration felling. In support of the use of the term "primary felling" I may point out that in several *chir* plans, "secondary fellings" are permitted. (In others, secondary fellings are not allowed. Whether it is better to allow these or not is another story which I do not intend to discuss at present). I mention this in support of my plea for the adoption of the term "primary felling" which leads naturally to the next operation, "secondary felling," where this is permitted.

I have written this note in the hope that other forest officers will give their opinions, and indicate what terms are in use in other parts of India, so that the best terms may become standardised for general use in describing the various stages of fellings under the shelterwood system; or at least as applied to *chir* forests.

LAND IMPROVEMENT AND FORESTS.*

By V. A. N. Sausman, M.B.E.

(Land Improvement Officer, Southern Circle, Bombay)

Man, who believes himself the conqueror of them, is at once the maker and victim of wildernesses, deserts and desolation. Both the old and the new world have innumerable examples of dead and buried cities typifying these facts.

Mankind wonders at the archæological finds being excavated and glories in their beauty. It takes steps to preserve them as wondrous monuments to posterity little realising that he is preserving to posterity monumental evidence of the folly of past generations. The massive masonry, elaborate carvings and extensive areas covered indicate that the people who built them probably felt a sense of security, permanence and accomplishment as solid as our own. Within a comparatively short space of time, by the ill use of the land and its products, he exposed the soil and let in the destructive forces of wind erosion which engulfed him and his world.

There are then the ruins of Baalbek, without compare in grandeur and preservation, those of Palmyra at the edge of the Syrian desert and of Byblos, whilst nearer home are those of Bijapur. These dead cities in their almost perfect state of preservation appear to have been asleep rather than dead. They have not been buried by erosion but stand high on their rock foundations from which 3 to 6 ft. of fertile soil has been washed away. The height of the lowest row of fashioned stone from the present ground level unmistakably demonstrates the depth of erosion that has taken place since the cities were first established. These erosion devasted areas are, in fact, extensive graveyards in which the cities of cut stone stand like tombstones, weathered into monotonous gray, blending with the exposed, skeleton rock outcrops of the surrounding country. Traces of the rich, fertile soil which once clothed these barren wastes are few indeed and they are confined to the narrow valleys where they were saved.

The ruins of highly developed architecture tell of the advanced culture of the region. The many archæological finds, in the forms of vats, jars, plates, etc. tell of past prosperity but within the space of a few centuries misuse of

*Paper read at the 6th Silvicultural Conference, Dehra Dun (1945), on item 6—The Afforestation of Dry and Desert Areas.

land, destruction of forests and natural vegetation, overgrazing by goats and erosion have converted these areas into complete man made deserts, void of vegetation, water and soil except in a few isolated pockets with a scanty cover of crops and thorny bushes.

The extent and beauty of all these ruins show that this desolation of the land has not always existed. The present rocky hills because of their barrenness are victims of torrential run off each rainy season. In summer however there is no water except that collected in small and rare pools. The following questions amongst others arise :—

(*a*) How can one account for the ruination of great cities built of material and architecture to endure the ages and in regions which to-day are denuded and poor, meagerly supporting a few miserable families ?

(*b*) How can one explain the former populous cities and their prosperity ?

The answer lies in the fact that these regions were once covered with extensive forests. Remnants indicate the species that once thrived whilst the architecture provides evidence of the forests. The construction of the buildings and churches required sturdy beams of wood whilst the interiors and ceilings were generally of wood. The furniture and fuel for heating the rooms and bath water required timber. The scaffolding to raise up the large stones and for building the edifices were also of wood. There must thus have been a sufficient supply of timber in the vicinity of these new dead cities and it must have been in such quantity as to cause no anxiety for the future. Pasture too must have been available in quantity to sustain the livestock which in Aurangzeb's army consisted of 15,000 horses and 2,500 elephants. To-day neither forest nor pasture is available. The removal of the natural vegetation evidently took place as a slow deforestation of mountains. The forests of the uplands were stripped both for their own product and for the sake of the ground they occupied. The produce that could be immediately utilized was extracted, whilst the remainder was burned. In this way was not only very valuable timber destroyed but the organic material present was also burnt. Such a clearing will yield a heavy crop for a few seasons by virtue of the fertilizer in the ashes and what little is left in the soil. In the space of a short time however the yield drops to the point where cultivation is no longer possible. A fresh clearing is made and the old one abandoned. Step by step cultivation proceeded further and further from the place of beginning. Whether the idle fields, in an ever increasing area around the cities, came to be covered by wind erosion or completely ruined by sheet erosion is immaterial. The ultimate result as evidenced by the hundreds of dead cities was the same. Man's conquest of nature was a brilliant illusion. Everywhere the net productiveness of the land has been decreased. Fertility has been consumed and soil destroyed by competitive farming at a rate faster than the capacity of man or nature can replace them. The acclaimed achievements of civilization have been built on borrowed capital to a scale undreamed of by the most extravagant of kings. The total would stagger any nation.

The many hundreds of dead cities are dead for ever because their soils are gone beyond any hope of reclamation. The cities can be made habitable again without any great effort and within reasonable expense. The buildings could be made more luxurious for habitation than any which exist to-day but man and erosion have devastated the area of its soil for a geologic age because the unpardonable sin of land misuse was committed. Nature rebuilds soil at the rate of one inch in a thousand years.

Soil is now known to be not a substance nor a mixture of useful chemicals but a biochemical phenomenon of the utmost complexity whose delicate balance is easily disturbed. The inexorable laws of cause and effect operate in the production of food from the soil just as in every other realm of physical experience. Your food is as rich as your soil, is as true to-day as it has ever been. No man, no community, no nation can spend resources faster than they are built and escape the inevitable reckoning. The dead cities prove that nations and communities have persished by erosion as by the sword. It is impossible to get something for nothing and to trust to the future for our errors to right themselves.

Except in a comparatively few countries the same old practices of ill use of land continue and we are now at the crossing of the ways. The time has arrived when a faulty step may mean starvation. It is therefore unfortunate that this period in the life of the world should coincide with the cry for industrialization and

with the cry for "freedom from want." It is now therefore time to decide on better land use and to make agriculture the foundation on which all other calls of life are built. It has been widely recognised that in backward countries the raising of living standards is tied up with the problem of developing—not exploiting—to the full agricultural and industrial potential and that the economic stability of the world depends on the prosperity and purchasing power of the vast agricultural masses. These call for sustained well-planned income from the land. Exploitation may give a sudden large income over a short period but must surely result in an early depression. Proper land use is the secret.

What is proper land use and in what way is forestry related to it? Proper land use means well planned agriculture allocating soil quality to its proper function so that a sustained, well balanced agriculture must result.

Mr. Henry Wallace, Vice-President of the U.S.A. asked in 1938 "Now what are the American goals worth working for?" "What are the things we must do to make this, our own land, the chosen land?" He answered his own questions by saying—"We want to see abundance widely shared." "What must we do to assure abundance for ourselves and our children and our children's children?" "Our first concern must be the land itself. Our agricultural fertility, our forests, our watersheds, our entire national life are bound up with the welfare of our soil. When the productive soil is ruined our civilization will be ruined and our country will revert to desert and waste land, like the ruined lands of Africa and Asia."

"Breathes there the man with soul so dead, who never to himself hath said," "This is my own, my native land" is patriotic but every man should now proceed further and ask himself the questions Mr. Wallace has asked. Will the answer be the same? I fear not for it has not yet been appreciated that enduring civilization is based on the soil. In 1896, Mr. N. S. Shaler, Professor of Geology at Harvard University, U.S.A., asked a very disturbing question. "It is now a question" he wrote "whether human culture, which rests upon the soil, can devise and enforce ways of dealing with the earth which will preserve this source of life so that it may support the men of the ages to come." He merely meant to ask whether an enduring civilization is possible.

There are only two groups of soils from the land use standpoint. They are (*a*) those which can be safely cultivated and (*b*) those which should never be cultivated. When soils which can be safely cultivated are cultivated they should be cultivated in such a manner as will maintain the soil structure and fertility but will reduce the effect of erosion to a minimum.

The key to soil conservation lies not in cure but in prevention. Proper land use, if begun in time, can prevent destructive dust storms and serious floods and will yield a hundred-fold in sustained income through conserving the soil fertility. Only minerals should be mined. Do not try to mine your soil. Whilst it is necessary for the farmer to produce as much foodstuff as possible to enable him to be at least partly self-supporting, it is equally important for him to conserve and improve his soil resources because the same need will exist for posterity.

The relationship between forests and agriculture is of the most intimate nature and the proper blending of the two results in better land use. There are the extensive forests of the high mountain and hill ranges where the vegetation is luxurious and those of the undulating or drier tracts where the forests are scrub. The former are in tracts of heavy or tropical rainfall and the latter in scanty or scarcity rainfall. The growth in the former is big, in the latter stunted. This statement is true both for the tree growth as well as grass. The water then is the *key* to this pattern. This does not necessarily mean the amount of rainfall, but the balance between the rainfall and evaporation.

In virgin or properly managed tropical forests the growth is a cathedral of massive, well spaced giant trees under whose dense canopy the alien and tangled rabble of the jungle does not thrive. Order and permanence are here. These giants bring forth young after their own kind, but only so fast as death and decay break the solid ranks of the elders. When man clears these forests and even turns them to fields, he cannot keep them for nature claims them again.

The dense and massive tree growth functions in many ways for better land use. The canopy breaks the force of the falling rain and permits

it to trickle down gently. It thus prevents the disturbance of the surface soil and the scattering of its particles to be engulfed in the rushing run-off. The annual fall of the leaves accumulates and a slow process of development takes place and is continued till a balance is struck. There are definite stages in this development and at the final stage a balance is reached. The plants and animals are delicately adjusted to each other and to the prevailing local conditions. They perpetuate themselves because their young can thrive unlike the weeds. This is the climax condition and where this obtains the resources of the soil. and plant life are at their richest. One of the most important factors about the climax stage is that the soil now contains the largest possible amount of humus or broken down plant and animal material.

The importance of this humus to better land use cannot be too strongly emphasised. Besides being exceedingly rich in nutrient material it tempers the soil against extremes of wet and dry. It holds water like a sponge and keeps it from scouring away the soil below. It assists the moisture to saturate into the soil and prevents floods. By its action water is released slowly, clear and limpid in the form of springs to flow in even measure throughout the year. In the comparatively drier areas the role of this humus is of equal importance. In such areas the rains are somewhat irregular and at times torrential. They are therefore more destructive. The restraining action of humus on rapid run-off reduces the danger of floods with their destructive action on hill and valley. Furthermore, the evils of drought are tempered by the same sponge-like qualities of absorbing water, thus keeping a reserve on hand to help tide over times of shortage. As the all important factor is not the amount of rainfall but the amount of water which saturates into the soil the effect of humus on moisture conservation is to indirectly increase the rainfall because it makes a given quantity of moisture go farther than it would otherwise. Man cannot change the rainfall for any given area but he can secure the benefits which would accrue from increased moisture by increasing and maintaining the humus in the soil. Conversely, by destroying humus, whatever benefits may come from rainfall are reduced.

In nature where man has not interfered, the whole trend of development is such that the utmost benefit is received from whatever moisture is available. By the addition of humus and the maturing of the soil the forest is able to move inland as far as possible. In fact it crowds the grassland so closely that the margin is a scene of constant struggle. The tree growth in itself acts as a steady influence on climate and wind whilst the roots make passages for the entry of water into the soil. With the water enter chemicals, etc. which collectively help in soil formation.

The removal of the tree growth with the aid of axe and fire, destroys all these benefitting influences and admits conditions for erosion and floods. At first the fields lower down are benefitted by the deposition of rich soil but within a short space of time sterile sand and gravel are deposited and destroy those fields or reduce their yield by the fact that the depth of the sand is such as does not permit the plough or the roots of crops to enter the rich nourishing soil below.

There are then those forests of scrub and grass which are fed by uncertain and very scarce rainfall. The moisture here is too little to permit of the formation of humus. The dead leaves lie like a carpet on the soil and effect a very beneficial influence on run-off and moisture content in the soil. The dead roots in the soil add organic matter to it and make the soil more water absorbent. The great dangers to these areas are overgrazing and fires. The chief causes of fires are those caused by wayfarers or deliberate firing to cause early sprouting of new grasses. The ground fire is the type of fire in such areas. It ambles its way along among dead leaves and grasses, licking its way around and past shrubs in a seemingly harmless manner especially as it does not appear to kill the shrubs. These fires however clear the forest of its soil covering and kill out the young seedlings. Though these fires cause the area, so burned, to be covered with green succulent grass, early in spring, the improvement of the pasture is more apparent than real because there is a slow but steady substitution of the grasses by weeds and soil depletion. The soil's capacity to hold water is steadily reduced resulting in run-off and erosion.

Whatever the type of forest, the effect of removal of vegetative cover is to cause erosion. The first type of erosion is sheet erosion which peels off the rich, soft, water absorbing top soil in a surreptitious manner like a thief in the night. This process goes on until the area

is bared of its absorbent layer. The removal of this top soil layer does not reduce the water absorbing capacity of the soil in direct proportion to soil removal but in an increasing degree because, as the lower layers are exposed they are less absorbent and harder. In consequence, they cannot hold moisture in sufficient quantity for it to saturate in the soil. The reduction of the top soil by erosion is arithmetical but the lowering of its water absorbing capacity in geometrical proportion presents a serious problem. This sheet erosion eventually leads to gully erosion which increased not by expansion but by multiplication in the formation of a number of small tributaries which join the large gully. Water, instead of soaking in the soil, rushes in torrents heavily, silt laden, and causes floods lower down. Engineers are called in to undertake work at the flooded site but as sure as night follows day the flood will appear in a subsequent year at another point because the engineer has not affected a cure but a palliative. Problems of erosion do not begin or end at field or village boundaries. They begin at the highest point in the catchment area and end at the lowest. The steady reduction of water absorption by the soil must end in the lowering of the subsoil water table. This not only affects vegetation including cultivation but also the water level of wells.

There is yet a third type of forest and that is the village and/or farm forest. Farm forestry is another avenue to better land use. Farm forests are extremely important to the country but it must not be forgotten that it is nevertheless only one branch of land improvement. The fundamental task is to encourage better use of land. Trees have played an indispensable part in any erosion control work from the very beginning of such work. They help to tie down steep hill sides or badly eroded undulating land that is unable to produce crops after years of continuous cultivation. They furnish a sheltering cover for worn out pastures that are practically devoid of forage and streaked with rainfall gashes. They serve to choke the growth of large gullies, to stabilise unsteady stream banks and to screen off cultivated fields from soil robbing winds. Trees will continue to be a most valuable tool of land use adjustment as they form a potent weapon of defence against erosion, floods, and silting and a means of increasing the productivity of certain farm lands, Eroded submarginal crop and pasture lands can, with profit, to the owner and the farm, be converted to forests. The many millions of privately owned acres of land of this nature in India should have a tree cover both in their own interests as well as for the benefit of lands, structures and people farther downstream. This can be accomplished if forests are considered not merely as stop gaps but as positive income producing parts of the whole farm economy. It is precisely at this point that farm forestry work has its most direct bearing on the basic land use problem. It is imperative to show that forestry on the farm is a paying proposition and to illustrate to the farmers that time, money, and energy spent in farm forests will yield satisfactory results. Once trees are recognized as a crop and treated with proper care, re-afforestation of unproductive fields and pastures will become a desirable move from every point of view rather than—as it now so appears—an unwanted economic sacrifice on the part of the farmer. To the individual farmer, co-operating in land improvement work, farm forestry should bring direct and tangible beneficial results. In addition to better protection to the soil it should mean a more valuable supply of timber and fuel for home use or for sale, saving the farm yard manures for field use, and better pastures. It is true that few fortunes are made from farm forests but they are a welcome source of supplemental income in all well managed ones. In a year of crop a failure productive farm forest may well provide the cash necessary to tide the family through the difficult period. In any event well managed farm forests should contribute definitely towards greater stability as a protection against soil eroding and soil drying winds. They have a a very important function to perform against soil drying winds. Experiments have proved that hedges which are very compact *i.e.* less porous, do not reduce wind velocities over large distances. Such hedges are however most effective when in a system of enclosed fields. Where the height of the hedge is 11 to 12 ft. the effectiveness is good for a horizontal distance of 150 to 170 ft. This is because the effectiveness of such a hedge is soon lost after the wind goes beyond it for a distance of more than 10 times the height of the hedge. A single row of hedge 13 to 14 ft. high exerted a retarding influence on wind velocity for a distance of as much as 20 times its height. These tests were for wind velocities of 3 miles per hour but the data was confirmed for wind

velocities of 10 to 20 miles per hour also and Dutch experts think the data will hold good even for greater wind velocities. Another point brought out by experiments is that trees with the lower bole clean are dangerous for the crops because they give rise to wind currents. Trees which branch heavily from low down are most effective. Taking everything into consideration, including the human factor, trees which propagate by root suckers are the most suited for work of farm forests because they form a dense screen against wind, replace wastage, by removal for fuel, at quicker rate than any other method and in this spread by root suckers they not only protect but help in soil formation. Many idle and run down lands will be rehabilitated and put to productive use by conservation to farm forests.

Farm or other forests are divisible into two main divisions—the dicotyledons and the monocotyledons. Trees fall within the former and grass within the latter.

Dicotyledons increase by secondary thickening and in doing so remove the epidermis. They thus remove the root hairs from all primary roots. *Ipso facto* they develop secondary and tertiary roots in the subsoil some distance below the surface soil and therefore are of little value in conserving the surface soil. Further, dicotyledons developing the tap root system penetrate the soil deeply but do not bind the surface soil. The tap root has a diameter of considerable size and though this accounts for considerable volume it has comparatively little exposed surface area for contact with the soil. In most dicotyledons the secondary roots, although not very numerous, expose more surface area than any other root division. The tertiary roots division, arising from the secondary, are the most numerous and have the greater total length but, owing to their small diameter, have a smaller surface area than the secondary roots division. Experiments carried out on the soyabean showed it as having root hairs on all but the primary roots system but the root hairs were so small as to have no binding effect on the soil. On the other hand the monocotyledons have no cambium and therefore increase their conductive or root capacity from the stem. This fibrous type root system is typical of grasses and binds the surface soil tightly. The binding effect is further increased by the fact that the root hairs of grasses are comparatively long and small in diameter, cover a large area and expose a considerable surface. It is this large surface area exposed by root hair members that is so important in binding the soil.

All soil in direct contact with roots and root hairs may be considered bound. Particles of soil closely held between the subterraineous members may also be considered free from erosion. In consequence, monocotyledonous plants with their small but numerous roots and root hairs and enormous surface are far more efficient than most dicotyledon in binding the soil. It is evident that the structure of grasses makes them a very important factor in soil conservation and therefore in the object of better land use.

Nature abhors a vacuum. She is no nudist but the world's greatest soil conservationist whilst man is the worst. Whenever an area is laid fallow, the slow and endless process of covering it begins. Whether the area is rock, sand, clay or soil there are venturesome kinds of plants, some very small and insignificant in size, which form the advance guard. Whatever the type, they soon change the chemical and other structures of the soil on which they grow. These early forms do not thrive under crowded conditions, and soon give way to grasses and other forms of plant life. This is but a stage towards the climax.

The grasses themselves fall conveniently into three height groups *i.e.* the tall, medium and short with roots striking an equilibrium with the crowns. These are in direct proportion to the moisture in the soil and the soil. The tall thrive in the areas of greater rainfall and the short in the areas of scant and irregular rainfall with poor soils and the medium come between. Very often the degrees of difference are met with in a comparatively small area and here the three height groups are often mixed in small patches. In wetter years the tall grasses flourish whilst in drier years the shorter do so. This mixture fits the grasses to meet all conditions and seldom are they caught off their guard with the vagaries of climate and rainfall. There is therefore little or no chance for a failure. Year in and year out the grass outturn is assumed but that of field crops, seldom. The inroads of the plough however affect the tall types more than the shorter and this is true even for conditions under excessive grazing or fire. Here too, then, water decides the pattern.

It is said that man would have been just another animal if there were no grasses. There is a definite connection between the first civilization and the origin of the culture of food grains such as wheat, maize, rice, sorghum, etc. All of them are developed grasses. No plant can ensure the continued browsing by beasts except grasses but by the domestication of certain highly favourable grasses man found bread, repose from unceasing movement and eventually civilization. No one can deny to the grasses the credit they deserve in elevating mankind from the beasts but neither can anyone deny the disgraceful treatment meted out to the grasses on the grazing lands. Yet grasses form the buffer between deserts and civilization and are therefore even more deserving of better treatment by man. Grass unlike forests has few friends and those only of recent standing. To most people it is simply a green carpet. All details about grasses pass notice from the casual observer. To him all is well that is green. To the traveller grasslands are of no consequence or even a bore as he flashes through the grassland in car or train. But grass affects our pockets and even our health when prices of milk or meat soar high through fodder shortage. We are then most vociferous, not to ensure and safeguard a food grass supply but to attack the authorities and the councillors.

Grasses come up year after year from the same underground clump and depend less upon seed than upon new buds. Each clump puts forth a few or many shoots each year, as conditions are favourable or not. They even suspend operations for a time under very unfavourable conditions and live upon their reserves. Under conditions of repeated fires and excessive grazing they however cannot hold their own and give way. Grassland once destroyed can however be restored though the greater the destruction the longer the time and the greater the effort required for the recovery. Protect them against grazing and fire and let what remains of the original vegetation fight it out with the weeds. There is no reason to worry about the issue for the rest cure will work wonders.

In the farming of the future, grass will no longer be the poor relative but the ace of all crops. Rotational farming in the future will rotate around grass not wheat, gram, or corn. This will be true both for poor and for rich soils. Grown on soils rich in nitrogen grass will, if grazed or cut when a few inches high, actually contain as much protein as green legumes. This factor is doubly important in times when protein concentrates are scarce or high priced. In a few weeks the grass is ready to be grazed or cut once again. On slopes too steep for cultivation it is more than a feed. It is the solution of the soil. Terracing or listing, prevents leaching of the soil, and conserves moisture and soil. Grass is thus helped to tide over the dry spells and when the rain returns this same carpet of green saves the soil from erosion by pelting rain drops. Renovation of pastures adds to their feeding capacity ; often doubles it. Starved root-bound sod is opened up by the tiller. In some conditions disc harrows can be used.

Grass is destined to play a major part in the new agriculture now unfolding. It promises new security for soils and for families. It permits the way to better human health through more nourishing milk and meat. Give thought to the promise of grass as you plan ahead and look forward to the methods and machines which will serve you best.

POST-WAR RECONSTRUCTION AND OUR FORESTS.

By S. V. Gulwadi

(Range Forest Officer, Yellapur, N. Kanara, Bombay)

Now that the war has victoriously come to a close all thoughts of the nation as well as of individuals are concentrating on post war reconstruction. Various plans for post-war reconstruction in different branches are going their rounds among persons interested in them; and I believe some suggestions and ideas for rehabilitation of our forests after the war from a forester will not be out of place.

We cannot close our eyes to the facts that our forests have been tapped very heavily during the present war and that the replacement programme has not kept pace with the cuttings, due to various causes beyond the control of individuals; the foremost being that of labour shortage. This does not mean, however, that our forests have been ruined beyond repair. Every forest officer, worth his training, has

tried his level best to fulfil the large war indents without transgressing the principles of silviculture as far as possible by

(1) light cuttings, over wide areas (thus preserving several big trees of valuable species for seed and natural regeneration).

(2) tapping unorganised areas and virgin forests which would have been uneconomical for exploitation in normal times.

(3) by concentrating cuttings on junglewoods, which had no timber value previously, thus saving valuable teak for the future.

Thus, it will be seen that the general idea of the layman (the public, including also some of the educated people) that our valuable forests have been ruined due to war supplies is unfounded. In fact, there have been certain indirect benefits to our forests due to the war, such as:

(*a*) In pre-war days, because supplies of teak were plentiful and fairly cheap (including those from Burma) it was the fashion to specify teak timber for every constructional use whether temporary or permanent and generally people would not care to use other timbers. Consequently our forests were getting over-crowded with these less valuable species at the cost of teak and the war has given us an opportunity to cut some of the superfluous trees to make room for raising more valuable timber species.

(*b*) Due to great demands and short supplies of timber in general, utility and uses have been found for untried junglewood species. By actual use and the confidence they have created, some of these timbers will continue to stay in the market. Instances are, the general use of *matti* (*Terminalia tomentosa*) for railway sleepers, the large and successful use of *Bombax* for matchwood, *heddi* (*Adina cordifolia*) and *kalam* (*Stephegyne parviflora*) for textile requisites and species like *kindal* (*Terminalia paniculata*), *jambul* (*Eugenia jambolana*), *ghoting* (*Terminalia belerica*) and *gulmar* (*Machilus macrantha*) which had hardly any demand before.

(*c*) Great impetus has been given to forest industries such as the manufacture of plywood, paper pulp and paper, production of raw rubber from *Crytostegia grandiflora* and preparation of charcoal fit for use in *producer-gas plants*.

(*d*) Publicity of the activities of the forest department without posters. In normal times people dreaded to visit far off forest localities; very few ever cared to know why the department existed. Now, on account of the tremendously expanded activities of the department, such as erection of sawmills and setting up of huge railhead depots in the very midst of populated places like Hubli and Dandeli and due to the large fleets of trucks moving to and fro from forest areas, people have realised, as never before, the vast amount of work going on and its utility in everyday life. The recent firewood control has brought home the fact from the richest to the humblest cottage dweller that without forests and their activities they would have starved. They now realise better how essential wood is to the individual from birth to death. Some forest officers have contributed a great deal to this phase by delivering lectures on forest topics in rotary clubs and arranging excursions to important forest tracts like Dandeli. This has roused considerable interest among educated classes and created a healthy respect for forest officers and their activities, and the contemptous term "*jungli*" is fast disappearing from the vocabulary of the enlightened people.

Hence I believe that if our forests are given a period of rest and the general policy of management suitably changed to suit the modern trend of thought developed during wartime, as a measure of necessity, *i.e.*, industrial bias and the programme of replacement doubled up by encouraging natural and artificial regeneration on a much bigger scale, it should not be difficult to catch up with the

lag created during wartime, and also improve our forests. As the whole trend of post war reconstruction is to envisage large scale industrialisation of India, the working plans officer should encourage by instructions, as well as by making provisions in working plans for the raising of plantations (as experiments in initial stages) of species found suitable or likely to be useful in the development of big industries like those of plywood, paper pulp, raw rubber, etc.; otherwise if we stick to teak only, the development will be unbalanced and we might not be able to utilise the full potential value of our forests.

This is how I believe it could be achieved:

1. *A period of complete rest.*—Exploitation to be stopped for a period of five years except the barest minimum necessary and complete enumeration to be done of the stock of valuable timber especially teak (which is not at all to be cut during the five years' rest). New working plans to be made to suit the actual conditions then arrived at; and even then, restricting the exploitation of teak to the minimum, as people have learnt the use of other timbers in war time. Now that the railways have learnt, under necessity, the use of *matti* and other junglewoods for sleepers and have found them suitable, the quota of teak sleepers to be supplied by the forest department could be curtailed to a great extent and much valuable teak could be saved. There has been a mushroom growth of sawmills during the war but unless many of these are closed down and only those maintained that would utilise only the lop and top from normal timber fellings there is grave danger that fellings in excess of the actual requirements will have to be undertaken to feed these monsters. Every observant forest officer will agree with me that in localities round about sawmills set up in the jungles especially old sites where once these mills existed, very little of teak is left.

2. *Heavy plantation programme.*—Wholesale plantations as well as patch plantations (*rabs*) according to existing plans should be doubled by taking two areas each year, where there was one in former days; and in five years' time, before the new plans come out, the regeneration programme, will be in line with the prescriptions of the existing plans. Some changes will have to be made here, *e.g.*, give greater latitude to and encourage broadcast sowing and dibbling of teak and other valuable species, in the gaps caused in the canopy here and there due to irregular fellings and allow the seed to establish as best as it can without the fuss of elaborate records. The existing plantations will have to be looked after better, by engaging silvicultural parties as whole time workers in charge of rangers, to go over all plantations due for thinnings and cultural operations, as a separate unit attached to each range, as the range staff will be fully occupied in raising new plantations and tending them from the year of formation to the stage of first thinning, thinnings being left over to the silvicultural parties.

3. *Staff.*—The most important problem to fulfil the above programme, appears to me to be the necessity of having enough and efficient staff to deal with the expanded programme of reconstruction. This can be achieved by attracting a better type of men to foresters' and guards' ranks by offering better pay and prospects. I have observed that generally the police force and military attract a better type of men than forest guards because they offer better living conditions and enjoyment of power. This would be counterbalanced if the pay and prospects are improved considerably, the minimum basic salary of a forest guard being raised to Rs. 25 and the grade of the first grade forester being raised to Rs. 75. Another anomaly that is frequently noticed is that the superior staff and the rangers are highly trained but the men who carry out day to day instructions, that is, foresters and guards, are given very little training which often results in their being totally incapable of following written and verbal instructions intelligently, resulting in bad work. It is necessary, therefore, to have a fully-fledged training school in our province, on the lines of the Balaghat training school in the Central Provinces with all the facilities and a whole time instructor appointed to it, who can devote all his attention and energy to the sole work of training and educating the lower staff in all the phases of practical forestry, and the course raised to one year. This will give them opportunities of seeing and learning all types of work to be carried out during the whole period of one year. The present half hearted course of six months adopted in this province makes it impossible to have a whole time instructor as he has to be provided with other work in the six months slack season. This makes it impossible for him to concentrate, as

he himself feels that he might be shifted to other duties during the period. Finally to give the best benefit of the training to the student, the instructor must be kept on the job sufficiently long because the instructor, a ranger, being new to the profession of a teacher, takes at least one year to study and brush up his own theoretical knowledge and learn how best to teach the course within the four corners of the curriculum.

Unless the men engaged in day to day life in forest work take interest in their work and are sufficiently intelligent and satisfied, the big improvement programme will merely remain a scheme on paper.

TEAK REGENERATION IN THE CENTRAL PROVINCES.*

BY SARDAR BAHADUR GURDIAL SINGH LAMBA, C.P.F.S.
(*Silviculturist, Central Provinces, Nagpur*)

Before 1926, teak forests in these provinces were worked under selection-cum-improvement fellings and the various conditions influencing natural regeneration did not show up clearly. The study of natural regeneration therefore did not receive adequate attention. With the introduction of the conversion into uniform method under recent working plans, the matter has been receiving considerable attention. The proportion of teak is increasing over large areas of forest on account of the ease with which nature provides regeneration where special problems do not exist due to the ability of teak to withstand adverse effects of cutting, frequent fires and heavy grazing, which factors prove more or less fatal to other species. There are several problems, however, requiring solution and scientific accurate knowledge of natural regeneration of teak is still to be gathered.

Teak forests in these provinces can roughly be distinguished into two types :

(*i*) *Dry type* preponderating in teak, frequently carrying pure teak crops.

(*ii*) *Moist type* which is more or less fully stocked and contains a large proportion of miscellaneous species.

Dry type.—This can best be considered as two sub types "very dry" and "dry," the difference being largely a question of rainfall. With some exceptions this teak predominant dry type mixed forest is confined to localities where the underlying rock is trap. Teak constitutes 40 to 90 per cent. of the crop as contrasted with 5 to 20 per cent. in the moist type. The very dry forests are not uniformly well stocked and grass may appear in profusion. The result is that the forests are either heavily grazed -for the demand for grazing is often complete—or else they get repeatedly burnt. Under either condition the factors of the locality may get more and more unfavourable for the reproduction of teak. A large number of teak trees in such forests are also past their prime and do not coppice satisfactorily. It is for this reason that clear fellings in such areas do not give very satisfactory results and are therefore not encouraged. Instead, all well grown immature growth is being retained as far as possible and no fellings of any kind are made in the very understocked areas.

As contrasted with this, the "dry" type bears better stocked forests with a larger proportion of miscellaneous species ; the growth of grass is less severe and the soil-moisture conditions are more favourable for advance reproduction of teak. It is not uncommon to come across forests with more or less full advance reproduction. These forests on being clear felled give an excellent coppice crop of teak with occasional *saj* (*Terminalia tomentosa*), *baranga* (*Kydia calycina*), *lendia* (*Lagerstroemia parviflora*), *tinsa* (*Ougenia dalbergioides*), *bhirra* (*Chloroxylon swietenia*) and certain other species to a lesser or greater extent which grow satisfactorily with the teak.

It would thus appear that the optimum conditions for inducing advance reproduction of teak are neither complete overhead freedom, as one would expect for a strong light demander like teak, nor too dense a canopy, but just that optimum degree of cover which preserves sufficient moisture in the upper layers of the soil to enable the tender seedling to tide over the period of intense drought, and yet admit sufficient light to enable the seedlings to grow year after year (after dying back), and thus develop a strong root system so that on coppicing them and clear felling the overwood a vigorous forest of seedling coppice is produced.

Moist type.—In the moist types of forest where teak is the most important species, we now know what areas are likely to regenerate successfully by natural means. Only such areas are clear felled or subjected to successive regeneration fellings. The main requisites for success are the presence of adequate advance reproduction of teak which is gradually coming up in these forests as a result of careful tending in the past, the presence of ample teak in the overwood which is still capable of coppicing satisfactorily, and above all such ecological conditions as are conducive to the development of the young teak crop, namely sufficient soil-moisture, adequate but not excessive shelter to the young crop where severe frost or intense drought are inhibiting factors, and freedom from root competition or overhead suppression

*Paper read at the 6th Silvicultural Conference, Dehra Dun, 1945. Communicated by the Chief Conservator of Forests, Central Provinces and Berar on item 5—The Natural and Artificial Regeneration of teak.

by grass, weeds, bamboo or the less valuable species. In chance gaps the valuable non-teak species and bamboos are being left unfelled and carefully tended. Such growth is also being left under the teak to allow the latter to grow straight and free from persistent epicormic branches. As the bulk of the species, with the probable exception of *shisham* (*Dalbergia latifolia*) and *tinsa* (*Ougenia dalbergioides*) are slower growing or less valuable than teak, the successive cleanings and thinnings are resulting in a uniform canopied crop with a higher percentage of teak than in the parent crop. Thus, although ecologically speaking clear fellings in the teak predominant moist mixed forests result in a vegetative regression to a more xerophytic seral phase from the point of view of management we are rapidly progressing towards a normal forest of the more valuable species. It is now generally admitted that although an undue dilution of the teak crop with a view to improve the soil moisture conditions is undesirable, the presence of evergreens or semi-evergreens as a second storey under the teak is likely to prove beneficial. Consequently, in the earlier clear felled areas where the aggressive bamboo regrowth was repeatedly cut back to let the teak up, further cutting up of bamboos has been discontinued. The bamboos are already showing signs of forming into clumps and we should thus eventually obtain a good natural under-storey of the shade tolerant bamboo which in years to come should yield a handsome return.

The only areas where some difficulty is still being experienced in getting the young crop up are the moister forests where the bamboo regrowth is very vigorous, or areas which are infested with *lantana*. Here a new technique is being developed, namely of uprooting the *lantana* bushes or repeatedly cutting back the bamboo, *in advance of clear fellings*. The results to date are encouraging. Where success seems doubtful the areas are being clear felled, burnt and planted up with teak.

As regards artificial regeneration, we are perhaps more advanced in our knowledge and practice of technique. This is due to the concentrated nature of work over small areas and the fact that failures when they occur are seen within a short time and these provide almost immediately an incentive to find out and adopt safer methods. Within the last 10 years we have made considerable progress. We have been guided by the good work done by the Madras forest department. Partial failure of natural regeneration in several valuable teak areas, *e.g.* Allapalli, Bori, Tenduchua worked under concentrated conversion operations on the introduction of recent working plans brought the matter to a head and the urgency of restocking them urged us to find out safe methods of artificial restocking.

There are however various matters about which our ideas are not clear. The best espacement at which teak should be planted and whether teak should be grown pure or a mixture should be encouraged are still to be decided.

An important detail of technique on which we have no definite knowledge under C.P. conditions is pre-monsoon stump planting. In Madras, the results of experiments have been successful. Some scrapy experiments in C. P. have given either unsatisfactory results or have been unsuccessful.

The war has greatly upset teak silviculture. Teak areas have been very heavily worked and a general overhaul of management of the teak forests is called for.

Teak occurs in several provinces. There is a danger of stagnation of ideas so far as this province is concerned. The same thing must occur elsewhere also. It is therefore essential that forests worked similarly and differently under similar set of conditions should be studied by experts together and the conditions influencing each area should be analysed and the results of past work discussed on the spot. This can only be done by a joint tour of experts from different provinces covering all the teak forests of this country. Such a tour is overdue. A complete record of the tour will be most beneficial.

SOME RECENT IMPROVEMENTS IN FOREST FIRE ORGANIZATION AND FIGHTING

By C. A. Connell

(*Forestry Commission*)

Introduction

There can be few foresters who have not at one time or another in their career had to fight forest fires with nothing more than man-power-equipped with birch-brooms, courage, and a fierce determination, and at the cost of great physical agony. All such have thought or forcibly expressed the view that it ought not to be beyond human ingenuity for man to be equipped more satisfactorily for this fight against a strong enemy. The present mechanical age has at last provided an answer to the problems. The technique of fire-fighting in forests has already been revolutionized, but much greater development lies ahead, and only awaits the passing of the present national emergency. A word of caution is, however, necessary. All who have fought forest fires by the new methods are agreed that these methods are complementary to the old, orthodox, purely manual ones, and while they undoubtedly will outshine the latter, will never entirely replace them, such is the variety of terrain, crop, and other local conditions encountered by the forest fire-fighter.

The Problems of Fire-Fighting

The efficiency with which a plantation fire can be tackled is dependent on the speed with which the alarm is raised, ease of access to all parts of the forest not only for men but for equipment, the speed with which adequate man-power and appliances can be warned and assembled, and the degree to which control can be exercised over the actual fire-fighting operations. It is axiomatic that an attack on a fire in its early stages is the ideal. A small number of men and appliances right at the start is worth more than a regiment of troops an hour later, and any Fire Plan should give this factor high priority. It is not, of course, suggested that provision should not be made for bulk reinforcements following up the initial assault party, but it is the latter that needs the careful and precise planning.

There are many forests in country characterized by mountains and low population per acre. Movement about the area is thus limited by gradients, watercourses, peat and bog sites, and so on. The collection of an adequate labour force from a country-side holding only

scattered cottages or farmsteads and many miles from an urban centre presents considerable difficulties, even if the problems of warning speedily all these people have been solved.

Years ago it was the practice when afforesting large tracts of land to have sufficient rides for administrative purposes only, and this resulted in compartments of up to 60 acres in extent. Doubtless the underlying idea was to have the maximum area under forest production, but the practice jeopardizes an efficient fire-control system from the start.

Fires have occurred and unfortunately are likely to occur in the future involving large tracts of forest, one thousand acres or more in extent and many miles in depth. Such an outbreak complicates enormously the efforts of a fire controller to co-ordinate his counter-measures and switch the forces at his disposal from one location to another rapidly, and even to get his orders transmitted and acted upon before they are outdated by the march of events.

The very state of a plantation has often in the past presented a barrier to the prevention of its destruction. Problems of expense and man-power have in some cases prevented the brashing of pole plantations or the removal of decayed and blown trees. These circumstances and similar ones make entry into the wood to get at the fire hazardous to life and limb.

MODERN DEVELOPMENTS

Access

It is the practice nowadays to pay considerable attention to ease of movement for men and machines about the forests. The manner in which access is provided in mountainous afforested areas, non-mountainous afforested areas, and reafforested areas of both types is the same in broad conception but varies in detail.

Where access routes are being planned and laid out before planting mountainous afforested areas an arterial system of main rides is laid down. These are based on a physical reconnaissance of the terrain, and make use of the most favourable natural features such as firm ground, gradual gradient, and absence of short-radius curves. Bridges and culverts are often necessary, and cognizance has to be taken of the possibility of landslides on to the road. The actual construction depends largely on skilful use of those modern juggernauts, the bulldozer and grader. The rest of the forest is compartmented out so as to give rides running along the contours and sub-compartmented by contourwise and cross-contour tracks, breaking the plan table area down into blocks, of as near to 5 acres as is practicable.

Where there is an established forest and a modern system of access is to be developed, the same layout applies, tempered of course by the desirability of incorporating existing rides. Felling out of strips is generally necessary and may entail bulldozing out of conifer stumps, but this is not often essential. The stumps can be straddled by vehicle tracks and men can run in between them.

In flat and rolling country such as East Anglia, the east Midlands, the New Forest area, the Black Isle, and so on, the problem is enormously simplified. Before planting or after a crop has been established it is an easy matter to lay out a complete access system on a rectangular basis of something approaching thereto, bringing blocks of trees down to 5 acres in extent. The bulldozer can cut firm routes for vehicles straight out on sand areas with low rainfall and Calluna vegetation at ½*d.* per yard super. On peat areas where drainage is essential, a grader can form a cambered ride with drainage each side for rather more cost.

Cut-over hardwood, conifer, and mixed woodlands are more expensive to condition for fire-access purposes, since large stumps frequently abound and a complicated system of drainage will brook no interference. Large stumps up to 5 feet across have been very successfully ejected from rides by a dose of 5–8 lb. of Polar Ammon Gelignite, the total cost being under 10 shillings per stump. The craters and the smaller stumps are dealt with by bulldozing. Watercourses are nowadays dealt with cheaply and permanently by the use of the appropriate size of unglazed or concrete pipes offered in wide variety by brick-works. Simply laid by hand and earth-graded over by machine, the resultant job is permanent and effective.

Width of rides

When planning the layout of a forest it is important to consider not only the number and location of rides and sub-rides but also their width. Rides are not connected only with fire-control schemes; they serve as places on which conversion of poles from thinnings can be carried out, and at the end of a rotation they serve as traffic lanes for the timber drags

extracting sawmill-size trees. In addition, rides are administrative boundaries and no forest can be worked in an orderly manner without them. A sense of proportion is necessary, however. The forester cannot overlook the fact that rides are normally unproductive, or that if rides were intended to be automatic fire-stops any forest would be, so to speak, all rides and no trees. Only when a forest crop is in its infancy, that is up to 5 feet in height, can a main forest ride be used as a fire barrier. After this time in a forest crop's life a fire is carried across all normal rides by sparks and the ride serves as a fire-fighting base-line only.

Thus there are restraining factors on any idea of over-generous planning of communication routes, and a severely practical outlook is necessary. Certain latitude is permissible from area to area, since local factors should never be ignored, and no absolute figure of width of rides in feet can be propounded, but it is normal practice nowadays to have a forest divided up into 25 acre compartments by rides 30 to 40 feet wide with perhaps one main arterial route of 60-feet width on a very large forest area. The internal or sub-rides forming sub-compartments of plantations need not be wider than 15 feet, and in the case of an established crop at the pole stage the removal of two rows of trees always meets the case. Such an arrangement of rides and sub-rides accounts for approximately 10 per cent. of the total area under management, and the loss of productivity entailed may be considered a reasonable premium for what is undoubtedly an adequate insurance against serious ravage. A point of importance in the assessment of acceptable fire risk and one not often appreciated is the uncertainty that one can ever replace exactly the damaged property. A burnt-down house can be replaced by an absolute replica simply by taking the architect's plans from the bank strong-room, but no one can say that in 20 years' time after a fire that has burnt down a 20-year tree crop one will have a new crop similar to the one lost. This element of considerable uncertainty is worth an extra premium to cover additional safeguards.

In the matter of detail, where sub-rides debouch into main rides the corner trees often have to be removed to allow a gentle turn. The stumps of coniferous trees up to 25 years old from no impediment if the trees have been felled in a workmanlike manner, that is with stumps flush with the ground. Many woodland areas in the districts enumerated have a solidity of soil and a type of vegetation which does not call for any bulldozing at all, simply the cutting of the ride or sub-ride.

Brashing of plantations

Allied to the above-detailed system of forest access is the present technique of brashing plantations so as to permit rapid passage between the rows of trees. Whether partial or complete brashing is done, the slash is generally packed into the alley-ways between the rows so as to leave every third or fourth alley-way entirely free from slash. This is of enormous advantage when fire-fighting at night. Nothing is more conducive to timidity than the fear of stumbling over branches and sustaining physical injury. The light of an ordinary torch is quite inadequate when the fire-fighter is looking into sheets of flame. The knowledge that the fire front can be reached down a cleared path maintains morale. The failure to brash established plantations was commented on earlier. Quite apart from the silvicultural desirability of this operation, brashing is a worthwhile premium against extensive fire losses. No one can satisfactorily fight a fire when hampered by dead and tough branches reaching to ground level. Eyes get damaged, clothes ripped, and speedy movement along the fire face or flank is prevented. Again, brashing has prevented many a ground fire from developing into a crown fire. The possible losses from a crown fire need no elaborating.

The use of water

The foregoing defence measures apply to all methods of forest fire-fighting. There has been developed in the State-owned forests of the United Kingdom, in addition, a specialized technique for fire-fighting involving the use of water. It was said for many generations that a forest fire could only be overcome by blood and sweat and that nothing in the way of water beyond the Wajax pack was applicable to the problem. This has been conclusively disproved in recent years. The technique has been developed on the basis of relatively small quantities of water transported to the scene of the fire and delivered by light-weight pumps of low consumption and high-pressure output. It is a fact that a small volume of water thrown at high pressure will extinguish

a crown fire in plantations up to 25 years of age, and will hold a fire in older woods until water on a more copious scale can be brought up. The fire is knocked out as well as watered out, and some idea of the force used can be gained from the experience of stripping the overbark down to the bast on a 20-year-old pine tree by playing a single jet on it.

There are on the market a number of pumps made of modern light-weight alloys by firms such as Merryweather, Johnson (Homelite), Scammel, and Evinrude, among others. These pumps, chiefly of the centrifugal type, consume water at the rate of 8 to 25 gallons per minute and eject it through one or two $\frac{1}{4}$-inch or 7/32-inch nozzles at pressures about 65 lb. per square inch. This results in a jet 60 feet long, capable of being thrown with force against the crowns of the average young and middle-aged coniferous crop. These pumps are powered by petrol engines ranging in size from $2\frac{1}{2}$ to $4\frac{1}{2}$ h.p. built as one unit with the pump and of modest petrol consumption. The usual equipment per pump consists of 400 feet of rubber or rubber-lined hose, one dividing breech, and two branch pipes with $\frac{1}{4}$-inch or 7/32-inch nozzles. With 400 feet of hose every part of a 5-acre block of trees can be reached by the jet of water. The pump with etceteras is transported together with a 500-gallon circular or rectangular metal tank of water on a lorry to the scene of the fire. Various types of lorries have been the subject of experiment, and of those available at the present time the type having twin-driven rear axles and Trakgrip tyres is the best for all terrains.

The use of water in small volumes at high pressure does not stop at power-driven and lorry-borne equipment. Considerable tactical development has been made in the use of an appliance which is an improvement on the canvas water pack of years ago. This is the Bantam hand-pump, consisting of a container of 3 gallons capacity with a hand-pump integral with the container. The pump gives a jet identical with the now all too familiar stirrup pump. The whole outfit, filled with water, can be handled by one man without undue fatigue and can even be carried full for reasonable distances up mountain sides.

A 10-cwt. van carrying one 50-gallon cube-shaped metal container of water, four Bantam pumps, and three men plus the driver forms an ideal emergency fire-fighting outfit which can be rushed to a fire immediately on receipt of the warning. There is a good sporting chance of such a team holding a fire in a young plantation until the proper fire-fighting forces arrive, while an outbreak in a newly planted area of bracken, grass, or Calluna vegetation can be quickly extinguished. Such an outfit is ideal for a small forest unit, where economic aspects preclude the purchase and maintenance of more elaborate equipment. A large coniferous forest generally has a power-driven pump on a lorry, as described earlier, as its spearhead of attack. Many fires which would certainly have developed into major conflagrations involving hundreds of acres of woodland have been either extinguished or held on check by the prompt use of such a vehicle. These outfits, known as Mobile Dam Units, have a crew of four including lorry driver and are held at instant readiness at Fire Control Centres.

Water-supplies

It is obviously of restricted utility having water fire-fighting equipment dependent on the Fire Control Centre for water. This aspect of the case has been met in waterless areas by siting large-cpacity metal tanks on gantries in the forest at points of known or potential high fire risk. These tanks, which hold from 500 to 5,000 gallons of water, give a very rapid gravity feed into the water-tank on the Mobile Dam Unit, 500 gallons being passed in under 5 minutes through a 2-inch fullway cock.

In the mountainous and other areas where natural watercourses abound, it is the practice to dam up a stream or dike and thereby form a reservoir from which a Mobile Dam Unit can replenish its tank. Nor is the use of such natural supplies confined to areas equipped with power machinery. Full advantage can be taken of every spring or rivulet or small artificial dam by placing beside it in a suitably contrived box one or more Bantam pumps. A small earth and stone embankment retaining 100 gallons of water, together with two Bantam pumps, forms a water fire-fighting unit ideal for isolated and mountainous parts. The fire-patrol men and scattered tenant workers, knowing the location of all such water appliances, can perform valuable service where otherwise the use of fire-beaters only would prove ineffectual.

There are types of fire hazard where the placing of Bantam pumps with related water-supply, either natural or artificial, is the most

sensible way of combating the risk. One such is the stretch of railway line known to have a bad record of fire-raising in young plantations. The placing of a 40-gallon steel drum of water and one Bantam pump every four chains down the section of line will enable one fire-fighter patrolling the length to cope with all but the worst the train can do, and the presence of so many water outfits will enable further fighters to cope with the worst.

Warning and Control

The developments in warning and fire control have not been spectacular as have other aspects of forest fire-fighting. This is not because technique has lagged behind, but because the war has prevented the necessary equipment being available. The observation tower and the telephone still remain the king-pins of most warning systems, while the uncomfortable motor-cycle is often the servant of the Fire Controller who wants to rush round the perimeter of a large fire.

TREND OF FUTURE DEVELOPMENT

It is likely that the greatest progress will be made in the spheres of transport, warning, and fire control.

Front-wheel drive vehicles with good clearance but low centres of gravity, and with power take-off for direct driving of pumps by the road engine, will undoubtedly be available. These will be able to traverse terrains which now tax the conventional lorries. Tracked vehicles on the lines of the famous Bren gun carrier will revolutionize methods in mountainous country. One can imagine the current Mobile Dam Unit being replaced by a team of three such carriers, one loaded with the water-tank, one with the pump, hose, and other equipment, and one carrying personnel. Their speed and manœuvrability will facilitate a lightning attack on the most difficult sites.

In the matter of giving warning of outbreaks of fire, science may provide methods which our forebears would have put down to Black Magic. The role of the photo-electric cell and the thermal unit is likely to be expanded beyond belief, and it is possible that one day forest areas will be guarded by all-seeing but unseen eyes, operating automatic alarms in the Fire Control Centres within minutes of smoke ascending and the temperature rising. Short-wave radio will assuredly be the medium of fire-fighing control within a short time after the present war is over. The advent of the 'walkie-talkie' and the more powerful car-borne transmitter will make possible an admirable system of co-ordination and control of personnel and equipment. One envisages the Fire Controller at the edge of the fire, seated in his car, headphones and larynx-microphone in place, studying his Map of the forest. Each ganger in charge of a squad has his 'walkie-talkie' and each mobile water unit its counterpart. The Controller gets minute-to-minute reports from fighting personnel and from observers posted round the fire area, and disposes his forces according to the changing conditions *via* radioed orders. On really large forests the Controller on the ground will one day be replaced by the Controller in his helicopter. Visual assessment of the course of the fire will replace verbal radioed accounts. The Controller will radio his orders to his ground forces and will realize the dream of every keen fire-fighting officer, to be able to see the whole fire in plan from above instead of part of it upwards from below.

As to the actual fire-fighter, the P. B. I. of the whole organisation, he may well be helped by the use of foam. At the present time putting out a forest fire by foam is often impracticable and always costly, but such fires have been successfully so dealt with, and the technique may well be developed and cheapened in the years to come. Asbestos protective clothing has also been used in isolated instances, and here again developments may be anticipated. Science will tame Nature.

Summary.—The subject of access to forest areas for fire-fighting purposes is being developed on lines of major and minor ride systems breaking down woodlands to blocks of 5 acres or thereabouts. The rides in difficult terrain are formed by bulldozers and graders.

The use of water has been very successfully added to the conventional beating technique for combating forest fires. The water may be manually -or power-pumped. Economic use of limited water supplies is ensured by low-consumption, high-pressure light-weight pumps.

Specialised vehicles derived from war developments, radio, and other scientific devices will materially aid the forest fire-fighter in the future.

The facilities for experiment, research, and development on the subject have been provided by H. M. Forestry Commission, to whom the writer is indebted.

Forestry, Vol XVIII (1944).

FORESTS IN MONTENEGRO.

BY N. WYLIE, F/LT., R.A.F.

The highest mountain range in southern Jugoslavia is the Dermitor in Montenegro, which has peaks of over 8,000 ft. The hills are mainly of limestone and springs are rare; valleys and hollows are commonly dry in summer. Yet the rainfall, including snowfall, must be at least 50, possibly 100 in. as at Cetinje there is 120 in., at Dubrovnik 60 in., and at Sarajevo which is further from the coast 35 in.

Some of the hills show bare with grey rock; on some there is fairly good summer grass; while on the western upper slopes, as you go down towards the Piva, there is a shallow black soil, which holds more flowers and herbs than grasses; and on some of the hills there are forests. The range to the east of Dermitor, separated by the plain of Zabljak, has some fine mixed forests. Here the hills rise to just over 5,000 ft., and descend to small plains or "poljes" at about 4,000 ft. The trees there are spruce, Scots pine, silver fir, beech, black pine, aspen, birch (rare), with juniper as underwood to the Scots. Usually only two or three species are found in one place, depending on aspect and elevation. On a slope facing south, there was practically pure Scots pine at the foot, then surprisingly a few black pine on a shoulder of the slope, including a dozen whacking old trees, which stood out flat-topped on the skyline; then on the flatter upper slopes the pine became less and spruce came in (Norway spruce or similar) and at the top silver fir and a very small quantity of beech. On the northern facing slope of the same hill there was at the bottom, spruce, with a few Scots pine, scarcely competing in vigour, but of good shape drawn up between the spruce; silver fir was sparse at the foot, but formed, a dominant part of the crop on the upper slopes, where a remarkably heavy stocking was found.

The density of the stocking in the best part of the wood was the most remarkable feature of these forests. There were patches of more or less even-aged spruce of middle size with a few Scots pine and silver fir of extreme density and apparently flourishing. And even more remarkable for the volume of timber standing were some areas, where the stand was of mixed age, every age-class being represented in ideal proportion, with plenty of small regeneration on the ground, so that the forest could have been kept perennially in that condition, yielding a noble harvest of the larger trees every few years. This stand had a large content of silver fir, with spruce and Scots pine in addition. It was nearly 5,000 ft. above sea level, facing north. The crop was possibly not the result of skilful management, but merely of limited exploitation, only large trees having been cut from it for the past generation, and little damage from grazing having chanced to occur. Where big trees had been felled recently, the gaps were filling up well with young spruce and silver fir. Felling had been inexpert and wasteful, large stumps being left. These woods were full of wild strawberries, which were very good.

The woods were unfenced; and near to houses and hamlets the trees were deformed by past grazing and pilfering. Little other damage from any cause was seen, except that many of the Scots pine were deformed by having lost their leaders at some time; this may have been due to weight of snow, as no squirrels were seen. There was no sign of forest fires, nor of any trees having been uprooted by the wind. There had been a slight tendency for forest to gain territory at the expense of adjoining grazing during the past 20 years. Where this had happened, juniper was the pioneer, and was followed by pine and spruce. It was not possible to see any recently sawn timber, as the local timber yard had been destroyed a few weeks earlier by some raiding Germans.

Sometimes the changes in species between one valley and the next were inexplicable. In a valley running east from the Dermitor there were no trees except beech, and they grew up to nearly 6,000 ft., but so low and stunted that cattle and ponies could graze the tops, keeping them clipped like hedges. Another valley running south was densely wooded with tall trees; the top end of the woods appeared from a distance to be of beech and silver fir. It should be mentioned, however, that there was a stream flowing all the year round down the southern valley and none in summer in the eastern one, in case that explained the different

crops. It was interesting to see beech apparently at home above the level where pine and spruce gave out. The altitude record was achieved by a sort of mountain alder, but the tree seen was only two feet high. (There was no way of identifying trees by referring to authority, so in writing of these woods, in some cases I have called a tree a "sort of alder" and in others I have ventured to give a specific name and call a tree a "Scots pine," if it looked like a Scots pine.)

In the Piva gorge the slopes were sadly covered with derelict woodland, where once there had clearly been some fine mixed hardwood forests.

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TEAK REGENERATION IN ORISSA.*

By J. W. Nicholson, C.I.E., I.F.S.

(*Conservator of Forests, Orissa*)

Teak is now so dominant on the horizon of our provincial planting programme that a brief account of past planting history is necessary. Teak occurs naturally in the west of Sambalpur and Koraput districts. It is not of good quality owing to dryness of climate and poor edaphic conditions. The most interesting developments have been in Angul and Puri divisions which at one time formed the " Orissa Division ". About 60 years ago a few teak plantations were formed in both divisions but, with one exception, in dry type forests. The teak produced is mainly quality III or IV but the crops have proved of far greater value than the indigenous forest they replaced. The work done in these two divisions from that period is best dealt with separately.

(a) Puri division

The early plantations were not extended. Just over 40 years ago a commencement was made introducing teak in lines half a chain to a chain apart in dense evergreen cum *Bambusa arundinacea* forest in the Mals of Puri, the most fertile tract of the division. Initial results were not too promising and early in 1923 the then Central Silviculturist (now Sir Herbert Howard) and I both came to the conclusion that the line planting had not been a success. Subsequent development belied our opinion. When Sir G. Trevor as Inspector-General of Forests visited the area with me early in February 1937 he stated that he had seen no finer teak anywhere either in India or Burma. Although in most provinces, and Madras in particular, it is believed that line planting or small teak plantations made in forest gaps cannot yield results comparable with regular teak plantations free from side shade and root competition, that has not been our experience in Orissa. Initially the growth is far poorer but later a great spurt in growth takes place. Owing to this line planting having been done in *Bambusa* forest the expenses of tending were very heavy and the method was never repeated.

In 1919 the *toila* method was introduced and it is the one now mainly followed. Present day technique consists of raising stumps in dry *rab* nurseries situated on the plantation site which eventually form part of the plantation. Pre-monsoon stump planting 8 × 8 feet is done if the *toila* cultivators have prepared the area in time; otherwise teak *donas* are used. Regular plantations are established by pre-monsoon stump planting at spacings from 6 by 6 to 8 by 8 feet according to quality of soil. Until this year these teak plantations have been made almost entirely in the Mals but under the new revised plan there has been a change of policy. The original line plantations since 1936 have been twice severely damaged by cyclones and the original oldest plantations were also damaged by a third cyclone. There is nothing on record to show that any damage had been by cyclones prior to 1936 but it is obvious that during its life-time a teak plantation is bound to be exposed to cyclonic damage. Under the revised plan teak plantations will be established in all miscellaneous type forests throughout the division. In dry type coppice felling series for instance, the rotation of which is 40 years, an effort will be made to plant teak over one-third of each annual coupe area. Further, in addition to teak other valuable more wind firm species such as *Pterocarpus marsupium*, Red sanders (*Pterocarpus santanilus*), sissu (*Dalbergia sisso*) etc., will be tried. Although the growth of these plantations in the dry forests of the division will not be equal to that in the Mals forest they will be in replacement of crops of little value except for fuel, and in more accessible localities. The extreme cheapness of establishing *toila* plantations (under Rs. 5 per acre) justifies our taking cyclonic risks.

Natural regeneration of teak soon occurred in the oldest plantations, but in the Mals line plantations, owing to heavy evergreen growth, it has been rather scanty. When the Inspector-General of Forests came round in 1937 we were carrying out a few experiments to induce

*Paper read at the 6th Silvicultural Conference, Dehra Dun, (1945), on Item 5—The Natural and Artificial Regeneration of Teak.

more natural regeneration. He classed them as unnecessary in plantations not half way through their rotation. We pointed out that we wanted natural regeneration in case of any cyclonic calamity. That very year the first bad cyclone occurred. Owing to the damage done these old line plantations now comprise of irregular growth of old trees, coppice shoots from felled damaged trees, and natural regeneration. Under the revised plan they are being treated under the selection system on a felling cycle of 10 years. Natural regeneration is being encouraged by shrub cutting and burning, and saplings and poles are being tended in cleaning operations. The results of this attempt to work a strong light demanding species under an intense selection system should be full of interest. Some of the older *toila* plantations were also damaged by the cyclones and these now resemble coppice with standards. If cyclonic damage continues to be a calamity occurring at irregular intervals the result will be that the even aged crops we started with will eventually become uneven aged.

(b) Angul division

After the early teak plantations of 1886 no further planting was done until 1919 when planting in lines one half to one chain apart cut through moderately damp forest of *sal* (*Shorea robusta*), other species and *Bambusa arundinacea* was tried on a small scale. When the province was formed in 1936 I found that these lines had been much neglected, much of the teak being suppressed. The lines were then tended properly with excellent results. In 1932 the Working Plans Officer commented on the height of one line plantation being only 15 to 20 feet: 10 years later it was 65 feet and is now about 70 to 75 feet. From 1927-28 a few small plantations were established with varying success. *Toila* methods were tried over a course of some years but did not prove successful, the growth being much poorer than in regular plantations and more expensive to establish. The 1932-33 Working Plan prescribed a minimum area of 50 acres to be planted up annually. Definite areas were allotted for such plantations. Unfortunately those areas were very badly selected being mainly in *sal* areas formerly forming part of P. B. V., and unsuitable, apart from the presence of *sal*, for the growth of teak. In many of the plantations established on such areas *sal* is doing better than teak and is being encouraged. Fortunately however the working plan programme of 50 acres was never worked up to and not much money was wasted. In 1936 I ordered that teak plantations should in future be confined to *Bambusa arundinacea* forest nearly all of which is suitable for teak and at present productive of practically no revenue. This policy, combined with improved pre-monsoon planting technique and the introduction of dry *rab* nurseries, has given excellent results and the prescribed area for planting was soon more than doubled. The prescribed spacing of 6×6 feet was altered in 1937 to one of 6 by 12 feet. In 1941 a spacing of $8\frac{1}{2}$ by $8\frac{1}{2}$ feet was tried over one-fifth of the plantation area. Early in 1942 the Central Silviculturrist inspected the plantations and criticised the 6×12 planting as conducive of strong side branches. On his recommendation the $8\frac{1}{2}$ by $8\frac{1}{2}$ planting has since been the standard distance. At the same time tests made after thinning 6 by 12 plantations have shown that at this spacing there were a sufficient number of good stems per acre.

Over 10 years ago I had experimented in Palamau division in Bihar with what we now call "interplanting" of teak. The teak was planted in lines about half a chain apart in forest due to be felled over in 2 years time. No weeding of any kind was done. As the results had shown promise I ordered experiments on these lines in Angul division and some were carried out in 1936 to 1939. Results again gave promise of success though there was damage from elephants (always a menace in regular plantations too). In 1939 while I was on leave gregarious flowering of *Dendrocalamus strictus* occurred in most of the valleys. On my return from leave I instructed the divisional forest officer to take the risk of success and in all flowered areas to interplant teak 33 by 9 feet, no planting to be done underneath principal species, and to concentrate on such interplanting in preference to regular plantations. This was done and in 1940 and 1941 some hundreds of acres were interplanted. The results have been unequal due in one case to a severe fire injuring the teak and stimulating bamboo growth and in many cases to elephants trampling down whole lines. Tending operations have had to be continuously carried out owing to the vigorous growth of bamboo culms but it has to be borne in mind that the interplanting was done one year later than possible. Had it been done in the year of planting far

better results would have been secured. Since 1941 interplanting of teak as well as other species has been continued with but in unflowered *Dendrocalamus strictus* mixed forest with promising results but we are still thrashing out the problem of the best technique. Normally no weeding is necessary but the staff tend to clear the lines thus resulting in damage by animals. By staggering the plants, by making the lines discontinuous, and by avoiding unnecessary clearances we hope to reduce animal damage to a minimum. Under present practice overwood shading the teak is girdled 6 to 18 months after planting by which time the teak is established and able to compete with weed growth stimulated by greater incidence of light. No defoliation had occurred to interplanted teak, though a common occurrence in regular plantations. Interplanted areas are calculated on the basis 160 stumps=one acre.

The working plan is now under revision. The area of *Bambusa* forest is limited and in any case is due to flower fairly shortly. In the oldest teak plantation natural regeneration of teak has been profuse. Contrary to the policy followed in most provinces of concentrating plantation work it was decided that it would pay us better to go in for interplanting with the object of introducing a valuable species such as teak where no valuable species at present grow, there being every indication that teak regeneration will follow over all the area interplanted. Further the costs of interplanting are very low. Including early tending they are not likely to exceed Rs. 2 per acre and if one-third of the plants survive we shall be left with teak spaced 33 by 27 feet wherever valuable species do not at present occur. In the revised plan there will be a prescription to interplant one-fifth of each selection coupe with teak, where the soil is suitable, and elsewhere with other valuable species, the felling cycle being 20 years. The planting will normally be done just before main fellings commence and the necessary cleanings and girdling of the overwood will be done 2 years later when fellings are completed. So far no advantage has been apparent in planting 2 years instead of one year ahead of canopy opening but a prescription of 2 years in advance allows for possible years of failure due to shortage of seed or other causes. The regular planting programme in *Bambusa* forest will be restricted to 40 or 50 acres but, if flowering occurs, all planting activities will be concentrated on interplanting in such forest. Such concentration of planting will naturally interfere with the ordinary interplanting programme and is another justification for doing the latter a year ahead of time.

Whereas in Puri division we visualise regular plantations ultimately becoming irregular crops, in Angul division irregular line planting in selection forests is likely, if natural regeneration occurs to the extent anticipated, to result eventually in the development of even aged crops from such regeneration.

In divisions other than Puri and Angul hardly any regular or *toila* teak plantations are being made but a good deal of interplanting is being tried on an experimental scale.

Photographs of Angul interplanting were reproduced opposite pages 160 and 161 of *Indian Forest Records*, Volume 5, No. 2.

FUARTER INFORMATION ON RED CUTCH (*ACACIA SUNDRA*) A SUBSTITUTE FOR LIGNUM-VITAE (*GUAIACUM OFFICINALE*)

By K. Ahmad Chowdhury,

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I. Introduction

In a previous paper,* it has been reported how the identification of red cutch timber was taken by up the Forest Research Institute. At that time, only in one locality namely, Baria state, in Gujrat, this tree was known to grow. A reference was made to the forest botanist and he reported that *Acacia sundra* has a very wide distribution. In order to know the exact places, within this wide distribution, from which red cutch could be obtained in commercial sizes, it was thought advisable to make a joint tour with Mr. Raizada, the Assistant Forest Botanist, to Bombay Presidency and some of the adjoining Indian States. This tour was made during April and May 1945, and further information collected on red cutch is reported here.

**Indian Forester*, Vol. LXX, No. 9, dated September, 1944, pp. 304–306. Also see *Indian Forester*, Vol. LXX, No. 11, dated November 1944, pp. 370-71.

II. Results of wood samples examined in the field.

The localities visited were the Panch Mahals division, Baria State, Rajpipla State, Dahanu and Kasa ranges of North Thana division and Bassein and Bhiwandi ranges of West Thana division. In all localities a few trees were found in flower and it was possible for Mr. Raizada to identify them as *Acacia sundra*. In not a single instance *Acacia catechu* was found.

In July 1944 when I first visited the Panch Mahals division, I could not find any red cutch timber in the timber yards of the local contractors. I, however, requested the D. F. O., Panch Mahals to send us botanical specimens from the local cutch trees. These specimens were later identified by the botanist as *Acacia sundra*. During my recent visit, I found red cutch timber in one of the timber yards. On enquiry I came to know of the forest from which this timber was obtained. We paid a visit to the forest and were able to see some trees in flower. Mr. Raizada identified these trees as *Acacia sundra*. It is, therefore, confirmed that red cutch grows in the Panch Mahals division and the quality of the timber is good and it will serve as a substitute for Lignum-vitae.

During my second visit to the Baria State, it was possible to examine a large number of samples in the timber yards and also see a good many trees in the forest. Red cutch timber in this locality seemed to be very good and appeared to have the qualities that are necessary for the lining of propeller tail-shaft bearings for ships. We also visited Rajpipla State. Here we could not see many big trees, although we saw some logs of fairly good size in a cutch factory. In Kasa range of North Thana division and Bassein and Bhiwandi ranges of West Thana division, we saw a fairly large number of trees in the forest and many local timber depots. In all these places, the quality of timbers examined was good and they appeared to be suitable substitutes for Lignum-vitae.

During this tour I collected over 50 samples of timber from different localities with a view to examining them in the laboratory later on. In the field some of these samples did not show much gummy deposit. I was doubtful whether they would serve as substitutes for Lignam-vitae.

III. Results of examination of the wood samplse in the laboratory.

A great majority of the samples collected proved to be suitable for the purpose, but some did not possess the required quantity of gum. It seemed that the timber above 10 feet from the ground did not possess a high quantity of gum in its cells. It is, therefore, doubtful whether the timber high up in the bole will serve for the lining of tail- shaft bearings.

IV. Revised specification for Red Cutch.

Based on the information that is available, the following specification for the selection of red cutch may be drawn :

(*i*) Straight-grained and clean-boled red cutch (*Acacia sundra*) trees over one foot in diameter should be selected. The larger the tree the better the timber. Hollow trees should not be selected.

(*ii*) The best timber seems to come from trees which have a low percentage of sapwood. As far as possible, trees with more than one inch wide all round sapwood should not be selected.

(*iii*) One bolt of 10 feet length or two bolts of 5 feet length from the bottom should only be selected. The rest of the log does not appear to be of good quality timber.

(*iv*) On the end surface the pores should be comparatively of small size and the rays fine.

V. General remarks.

The impression I gathered during this tour is that red cutch usually grows in dry localities on rocky soil. The main crop is teak with scattered red cutch and a few other species like *Bassia latifolia*. *Terminalia tomentosa*, *Anogeissus latifolia* and *Sterculia urens*. The rainfall is between 35 inches and 40 inches in Baria State and Panch Mahals division. In other localities in Bombay Presidency although the rainfall is high yet the soil is known to be physiologically dry laterite.

There still remains some more localities to be visited to enable me to write up the final report. In the meantime, I take this opportunity to thank Mr. Kesarcodi, Forest Utilisation Officer, Bombay Presidency, for his help and co-operation during this investigation.

IRRIGATED PLANTATIONS OF THE PUNJAB.*

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Part I—Descriptive.

1. *General.*—It is difficult for the present generation to believe that not many years ago the Punjab consisted largely of vast areas of desert, with only sparsely scattered tree growth consisting of *Prosopis spicigera, Capparis aphylla, Salvadora oleoides* and *Tamarix articulata*, these being the only source of firewood for the province. With the increase of irrigation a good deal of this desert area was brought under cultivation and Lyallpur and Montgomery districts have grown on this barren waste within the memory of men. Due to the growing population of the province and of the towns, the Punjab Government had to face the difficult problem of the supply of firewood for domestic or industrial consumption.

2. *Government Policy.*—The establishment of irrigated plantations in the Punjab was the direct outcome of the policy of the Punjab Government in regard to the reservation of land for raising tree crops to meet the demand for fuel. Accordingly, the first irrigated plantation was started in 1866 by the Punjab Forest Department at Changa Manga. Subsequently the Punjab Government considered the possibility of utilising unsuitable areas on other canals. Owing, however, to the unsuitable situation of the only available areas on the tails of distributaries which could not give sufficient water, a number of these had to be rejected. The rejected areas included 30,000 acres near Pir Mahal, 15,000 acres near Lahore, 15,000 acres near Gujrat and 15,000 acres at Okara on the Lahore-Multan Railway. Finally the following areas were selected :

Khanewal, Chichawatni, Arifwala, Depalpur, Miranpur, and Daphar plantations. These are described below :

3. *The Situation of the Plantations.*—The Changa Manga plantation is situated in Lahore district 44 miles from Lahore on the Lahore-Karachi Railway.

Chichawatni, Arifwala and Depalpur are in Montgomery district. Chichawatni is on the Lahore-Multan Railway, 129 miles from Lahore. Arifwala is 19 miles from Montgomery on the Montgomery-Arifwala metalled road.

Depalpur, named after an old town is 12 miles from Okara railway station, on the Lahore-Karachi line.

Khanewal is in Multan district and lies in the angle between the Khanewal-Lahore and Khanewal-Lyallpur railway lines.

Miranpur, also in Multan district is 5 miles from Gillanwala railway station on the Multan-Karachi line.

Daphar is in Phalia tehsil of Gujrat district. The nearest railway station is Pakhowal on the Malakwal-Sargodha railway line.

4. *Area.*—The gross area of the Changa Manga plantation is 10,845 acres of which 10,275 acres are stocked. The dry *rakhs* of Maujoki and Shahpur Jand covering an area of 1,671 acres are from the point of view of management a separate unit. No further extension in the planted up area is possible with the existing water supply.

The gross area of the Chichawatni plantation is 11,494 acres. Of this area, 9,787 acres have been planted up. The present area of the Arifwala plantation is only 1,519 acres, of which 1,178 acres are completely stocked. The original area of the plantation when it was started in 1929 was 9,838 acres, but 8,320 acres were disforested.

Of the total area of the Depalpur plantation, (5,610 acres) 2,207 acres are under tree crops and 1,400 acres are under temporary cultivation of which 200 acres are annually released for plantation.

The gross area of the Khanewal plantation is 19,281 acres, of which 14,185 acres are fully planted up. The area under temporary cultivation is 2,731 acres and under roads, water-courses etc. 2,365 acres. The present area of the Miranpur plantation is 3,267 acres, 6,727 acres being disforested and made over to the Nilibar colony in 1942. The question of resumption of the abandoned area is again under consideration

*Paper read at the 6th Silvicultural Conference, Dehra Dun, (1945), on item 6—The Afforestation of Dry and Desert Areas.

The gross area of the Daphar plantation is 7,126 acres of which 6,622 acres are planted up.

5. *Soil*.—The Changa Manga soil is deep alluvial sandy loam, the proportion of clay varies from place to place. Deposits of concretionary lime (*kankar*) and alkaline salts (*kallar*) occur in patches of small size. The original soil has improved considerably due to the addition of humus from decayed organic matter during the last 70 years.

The Chichawatni soil is a fine clayey loam and retentive of moisture. The depth varies from 17 to 25 feet. There is a fairly large area of *kallar* soil.

The Arifwala soil is very poor. Alluvial in origin; it varies in depth from a few inches to not more than 8 feet above the sand level. At places the sand comes right up to the surface.

In Dipalpur, the soil is also of alluvial origin. It varies in composition from sandy loam to clayey loam, the former type predominating. Patch of *kallar* and hard sodium soil are scattered throughout the plantation.

The Daphar soil is an alluvium characterised by the varying degrees of porosity depending on the relative proportion of sand to clay. On the whole the soil is suitable for tree growth. The sand horizon is at a depth of 15 to 20 feet. *Kallar* salts (alkali) have more or less disappeared with cultivation and irrigation and do not show except in a few small patches. *Kankar* occurs in okaces characterised by poor tree growth.

The Khanewal soil varies from sandy loam to heavy loam or clay. It is 8 to 25 feet deep overlying a pure sand horizon.

6. *Irrigation System*.—The Changa Manga plantation is irrigated from the Upper Bari Doab canal, main branch, lower. The irrigation season is from the 1st April to the 30th September. Only surplus water in the canal is passed into the plantation without any guarantee whatever of a minimum supply. There are 17 forest outlets. The total length of mains, branches and feeders is roughly 70 miles and the net work of *khals* about 225 miles. A peculiar feature of the irrigation system is that the discharges of *khals* and branches are not fixed but variable; a variation in the discharge of *khals* from 6 to 12 cusecs is not uncommon. Changa Manga is the classical example of the application of the flood system to plantation crops. For this purpose the areas are divided into 2 to 4 acre plots by means of bunds.

It is true that trenches are reopened in the regeneration areas but these soon silt up and are completely obliterated after 2 to 3 years, so that subsequent irrigation is typically by flooding the 2 acre plots. The delta delivered in each watering varies from 1 to 2 feet, due to variable supplies in the canal and defective distribution of water. *This needs overhauling.* The heads of forest channels are obsolete in design, defective, pass excessive silt and so need remodelling. The annual delta averages between 3′ to 4′; during 1944-45 it was 5 feet which is exceptional. Payment for the water to the canal department is made on a lump sum basis and is Rs. 40,000 per annum.

In the Chichawatni plantation the irrigation season is from April 1st to October 15th. The discharge from 13 L and Sunderwala distributaries which irrigate the plantation, is 144 cusecs. There are 27 outlets of the *pacca* flume type with a discharge of 130 cusecs. The length of the mains is 68 miles and of the *khals* 193 miles. Payment for water is made on the lump sum basis, Rs. 57,000 per annum. The *khals* are of the standard size that is $\frac{3'+2'}{2}\times 1'$ in section.

Irrigation is done by the trench method. Before 1938 a "shallow and repeated" system of irrigation was in vogue in the plantations. Under that system waterings were frequent during the season but not more than 6 inches were given at each watering. In 1938 as a result of observed deterioration of the crops, the shallow system was condemned as unsuitable, at any rate under Chichawatni conditions, and deep irrigation was introduced. This has proved beneficial.

According to the "deep" method of irrigation not more than 2 to 3 waterings are given to plantation crops during the season, but the *minimum delta delivered each time is 12 inches.* In actual practice, water is let into 9-inch trenches which are kept filled to overflowing until the moisture from contiguous trenches meets. The total delta delivered during the season is however different in the west and east ranges; conditions are more favourable in the east range so that it gets a relatively larger share of the delta. Trenches are reopened after the final felling and after the first and second thinnings.

As a rule silt clearing of the mains and *khals* is done once a year during the winter months. However *khals* which badly silt up are cleared as and when required, during the irrigation season.

In the Arifwala plantation, the irrigation season is from April 15th to October 15th but the water supply is very uncertain and cannot be relied upon except during the flood months, July to September. Generally there is a shortage of water for the plantation due to the inadequate supply in the Sutlej valley project canals and on account of breaches upstream. The discharge of the distributary is 22 cusecs. Payment for water is made on the volumatic basis at Rs. 5-8-0 per acre per annum. There are 7 outlets of the *pacca* flume type. The total length of the mains is 5 miles and of the *khals* 44 miles. The *khals* are of the standard size $\frac{3'+2'}{2}\times 1'$. Irrigation is by the trench method. Since 1938 instead of the "shallow and repeated" method, "deep" irrigation is given to the crops, a 1 foot delta being delivered at each watering. The total delta delivered during the season is 4 feet. Trenches are reopened after thinnings. Silt clearing is normally done once a year, but *khals* which silt up badly are cleared when necessary during the season.

In the Dipalpur plantation, the conditions of the water supply are practically the same as at Arifwala. The discharge of the minor which carries the supplies for the plantation is 58 cusecs. The irrigation department has agreed to payment on a volumatic basis of Rs. 5-8-0 per acre per annum. The flow in the channel depends upon the fluctuations of the water in the rivers. Although the flow period is April 15th to October 15th the supply is not sure except during July to September. There are 7 outlets of the *pacca* flume type. The discharge of the forest outlets is 30 cusecs. The total length of mains is 82 miles. *Khals* are of standard size $\frac{3'+2'}{2}\times 1'$. Since 1938 deep irrigation is given in 9-inches deep trenches which are reopened after thinnings.

In the Khanewal plantation, irrigation is done by a forest distributary and 2-minor issuing from it. The total discharge of the forest distributary is 246 cusecs. The irrigation season is April 1st to October 15th. Payment for water is made on the volumatic basis at Rs. 5-8-0 per acre per annum. There are outlets including those exclusively meant for the temporary cultivation. The outlets are of the *pacca* A. P. M. and open flume types. There are 28 miles of mains and 396 miles of *khals* in the plantation. The old *khals* were $\frac{4'+3'}{2}\times 1'$ in section, but the new ones are smaller $\frac{3'+2'}{2}\times 1$.

Irrigation is applied in trenches at least 9 inches deep. For old crops the first irrigation is 12 inches deep and subsequent irrigations during the season 9 inches deep. In the case of new crops, waterings are frequent and 6 inches deep. For the old crops the delta is 4 feet and for the newly planted areas 6 to 7 feet during the first year. In the two-year old crop the delta delivered is 5 feet.

The Miranpur plantation is situated on the Bahishti and Mahmud distributaries of the Mailsi canal of the Sutlej valley project. Very little water is available in the distributaries during April to June; the supply conditions are now satisfactory during the monsoon when the Sutlej is in flood. Except when the channels run full during July and August, water can only be supplied for the plantation on a share supply basis. At present no irrigation is being given to the existing crop.

In the Daphar plantation a 2 feet delta is delivered to crops of 5 years of age and over, and a 3 feet delta for younger crops up to 4 years of age. Surplus water if available, is then applied to backward crops. The plantation is irrigated from 4 minors with a total discharge of 67 cusecs. Payment is made on the volumatic basis at the rate of Rs. 4-8-0 per acre per annum. The total length of the minors is 10 miles. There are 20 outlets all of the open flume type. The total length of the mains is 56 miles and of *khals* 208 miles. All the mains have bed width of 3 feet. The *khals* are of standard section $\frac{3'+2'}{2}\times 1'$. It has been found necessary to reduce the centres by making 12 feet wide cross roads in between two *khals*. Reopening of trenches is done in the 3rd, 6th and 11th years. Minors and mains throughout the plantation are annually cleared of silt in the winter. *Khals* are cleared as and when necessary even in the flood season. One great difficulty in the way of silt clearance of the *khals* is the shortage of labour in the plantation.

7. *Sowing, Planting and Tending.*—In Changa Manga, planting and sowing are done

in the regeneration coupe only. After debris burning, the area is trenched (trenches 6″ to 9″ deep and 10′ apart), divided into 2 acres plots by means of *bunds* and planted up 10′×6′ with *shisham* (*Dalbergia sissoo*) stumps. Mulberry (*Morus* spp.) seed is scattered with the irrigation where required. On account of the heavy weed growth three weedings are essential in the first year during the hot weather. *Bathu* (*Chenopodium album*) is the worst weed and extremely difficult to eradicate. *Kana* (*Saccharum munja*) is a dangerous pest only kept under control by persistently stubbing. Coppice cleanings are important and are carried out in the young crops at the end of the first year's growth: the object is the reduction of the multiple shoots to 2 to 3 per stool. Three thinnings are carried out in the 6th, 11th and 14th years.

In Chichawatni planting is done over 400 acres, using 40,000 root and shoot cuttings stumps annually. In the regeneration area debris burning after final fellings followed by the reopening of the trenches to a depth of 9″ are routine operations. In the regeneration areas, frequent weeding are necessary in the first year. The crops are thinned in the 7th and the 14th years.

Kana is stubbed out every year. Failed areas are restocked.

In Arifwala no plantings and sowings are done. Fellings, as well as the extension of the plantation being stopped, there is no regeneration or afforestation area for annual stocking.

Thinnings are done in the 6 and 14 years old crops. *Kana* is completely eradicated annually.

In the Dipalpur plantation 200 acres are annually taken up for afforestation. Over 1,00,000 root and shoot cuttings are planted.

One weeding is essential in the first year, and a second weeding is often necessary. Thinnings are done in the 6th and the 14th years.

In the Khanewal plantation the annual progress of afforestation is 160 acres. Actually in 1944, 350 acres were taken up to work off past arrears and 500 acres are scheduled for planting in 1945. Apart from the afforestation and the regeneration areas, under planting is done in the 1st thinning areas of the 1st rotation. The amount of underplanting work involved varies from year to year depending upon the first rotation areas included in the first thinning coupe. In 1944 the underplanted area was 147 acres and 16,900 mulberry cuttings were planted in it. In 1943, 591 acres were underplanted with 73,144 mulberry and 22,780 *bakain* (*Melia* spp.) cuttings.

The crops are thinned in the 6th and 12th years. Mulberry, *bakain* and other species interfering with *shisham* are cut back in the first year, and in the subsequent thinnings. Coppice clearing is done in the regeneration areas at the end of the seasons growth.

Kana is stubbed out over the whole area and at least 2 weedings are necessary during the season in the first year in the planting areas.

In the Daphar plantation interplanting is done over 400 acres of regeneration area annually. The average number of *shisham* and mulberry cuttings put in per acre is 200 and 350 respectively. The number of mulberry cuttings underplanted are 200 to 500 per acre. Two thorough weedings in June and September are done in the first year as weed growth is very heavy in the coppice areas. Mulberry is favoured against *shisham* coppice so as to obtain a 50 per cent. mixture in the final crop.

8. *System of Management, Growing Stock, Yield.*—The Changa Manga plantation which dates from 1866 has been managed under the "coppice with standards" system with a rotation of 8 years for the coppice, and 54 years for the standards. In actual practice the coppice reproduction is supplemented by sowing and planting for complete restocking. The crop consists of *shisham* and mulberry as the principal species with *bakain* (*Melia azedarach*) and *Eucalyptus rostrata* as auxiliary species. *Acacia farnesiana, Prosopis juliflora* and *Prosopis glandulosa* occur in dry situations. The plantation started originally with a pure *shisham* crop but mulberry has gradually spread naturally from seed dispersed by water, birds and animals so that the present stand consists of over 80 per cent. mulberry.

In the growing stock, all the age classes are normally distributed. Poor and under stocked areas are estimated to cover about 1,200 acres. About 15 well grown *shisham* trees per acre evenly distributed over the area are retained as standards for the final fellings. The distribution of these standards by ages is very uneven thus standards of the 2nd and 3rd rotations are very deficient, due to heavy casualties caused by fungus, wind and isolation.

The annual yield from the main fellings and thinnings during the current rotation, 1936-37 to 1944-45 is as under :

	Shisham timber c.ft. (*solid*).	Mulberry and *Bakain* timber c.ft. (*solid*).	Total timber c.ft. (*solid*)	Total fire-wood c.ft. (*stacked*)
Main felling	39,821	44,705	84,526	1,367,233
1st thinning	168	145	313	413,370
2nd thinning	291	13	304	475,529
3rd thinning	1,114	1,530	2,644	411,789

Compared with the working plan estimates the firewood yield shows a falling off by 36% for the main fellings, as is seen from the following statement :

	ANNUAL YIELD PER ACRE FOR THE PERIOD 1936-37 TO 1944-45.			WORKING PLAN ESTIMATE OF THE ANNUAL YIELD PER ACRE BASED ON THE PREVIOUS ROTATION.		
	Shisham timber c.ft. solid.	Mulberry, *Bakain* timber c.ft. solid.	Fire wood c.ft. (stacked).	*Shisham* timber c.ft. solid.	*Mulberry* timber c.ft. solid.	Fire wood c.ft. stacked.
Main felling ..	68	77·0	2,347	90	65	3,675
1st thinning ..	0·3	0·3	818	..	..	620
2nd thinning ..	0·4	..	728	..	..	610
3rd thinning ..	2	2·7	774	..	..	610
			4,667			5,515

Chichawatni plantation is managed under the coppice with standards system. The total volume of the growing stock is estimated at 1,00,00,000 c.ft. and of standards 2,90,000 c.ft. solid. The distribution of crops, by quality classes is Q I 55 acres, Q II 891 acres, Q III 6,806 acres and below Q III 2,032 acres.

The annual yield from the main fellings is 10,80,000 c.ft. stacked. from the first thinning 2,00,000 and from the second thinning 1,76,000 c.ft. stacked.

The growing stock of the Arifwala plantation is estimated at 7,92,400 c.ft. The whole crop is below quality III and poor in stocking so that it has been necessary to stop working the plantation on the sustained yield basis.

Dipalpur plantation. The volume of the stand is estimated at 13,97,800 stacked c.ft., the crop quality is below III, hence the plantation is not worked for an annual yield.

In the Khanewal plantation *shisham* is the principal species. *Earash* (*Tamarix* spp.) occurs in areas not suitable for *shisham*. Mulberry has been introduced in areas where moisture conditions are favourable. Outstandingly successful has been the introduction of an understorey of *bakain* to fill up gaps in the *shisham* overwood.

The distribution of age classes is as under:

Age class (years.)		Area (acres.)
1—3	..	1,787
4—6	..	3,993
7—9	..	3,635
10—12	..	778
13—15	..	1,364
16—18	..	2,052
19 and above	..	576
Total	..	14,185

The volume of the growing stock is estimated at 1,50,00,000 c.ft. stacked.

The annual yield varies between 12 and 15 lacs c.ft. (stacked) from the main fellings, first and second thinnings.

The age class distribution of the growing stock in the Daphar plantation is as under :

Ages class.		*Areas (acres.)*	*C.ft. (stacked.)*
1—5 years	..	1,840	10,32,000
6—10 ,,	..	2,317	22,08,500
11—15 ,,	..	2,110	27,99,000
16—20 ,,	..	315	5,30,500
Total volume		..	65,70,000

In addition, there are 69,070 *shisham* standards in timber contents 1,40,000 solid c.ft. and firewood 11,00,000 c.ft. stacked. The annual yield from the main fellings is approximately 4,00,000 c.ft; from the first thinning (II rotation) 2,00,000 c.ft; and from the second thinning (II rotation) 2,50,000 c.ft.

Financial results.—The cost of the formation of the Changa Manga plantation was Rs. 5½ lacs including the value of the land. This was worked off by the end of the second rotation when the plantation began to show a small surplus even after allowing for interest at 4 per cent. on the capital outlay. At the end of the third rotation the net surplus amounted to Rs. 38¾ lacs or Rs. 20 per acre per annum, after writing off further capital costs on the extension of the plantation by 1,200 acres and on the installation of a two foot guage steam tramway. In the current rotation, the returns are even higher as seen from the following statement of revenue and expenditure for the period 1936-37 to 1944-45 :

Year.		Gross revenue.	Expenditure.	Net revenue.	Net revenue per acre per annum on 10,845 acres planted area.
		Rs.	Rs.	Rs.	Rs. a. p.
1936-37	..	3,35,652	1,90,202	1,45,450	13 6 7
1937-38	..	3,42,806	1,86,645	1,55,661	14 5 8
1938-39	..	3,29,511	1,60,509	1,68,902	15 9 2
1939-40	..	3,33,738	1,87,121	1,46,617	13 8 4
1940-41	..	4,06,671	1,71,681	2,34,990	21 10 8
1941-42	..	5,32,455	2,10,614	3,21,841	29 10 10
1942-43	..	7,54,576	2,83,831	4,70,745	43 6 6
1943-44	..	12,08,850	3,31,261	8,77,589	80 14 9
1944-45	..	15,23,348	3,96,632	11,26,716	103 14 3

The estimated value of the permanent forest estate is Rs. 1,00,00,000.

In the case of the Chichawatni plantation the formation cost was Rs. 10,04,318, the total expenditure to date is Rs. 21,71,185 and the income Rs. 28,73,594. The net return is thus Rs. 7,02,409 which works out to Rs. 15-13 per acre per annum.

The Arifwala and the Dipalpur plantations are on a rather different footing, being still in the formation stage. The total expenditure on the Arifwala plantation is Rs. 3,76,942 which exceeds the total income (Rs. 2,82,490) by Rs. 94,462, so that there is still a deficit to make up. The total costs in the case of the Dipalpur plantation are Rs. 4,73,981. This amount is more than offset by the income of Rs. 5,41,485 so that there is already a surplus of Rs. 67,504 in the formation stage.

The cost of formation of the Khanewal plantation was Rs. 17,29,000. With a total revenue to date of Rs. 44,91,055 and total expenditure of Rs. 36,15,309, the surplus is Rs. 8,75,746, Rs. 2-4-0 per acre per annum in the second rotation of the plantation.

The total formation cost of the Miranpur plantation was Rs. 4,00,000.

The cost of formation of the Daphar plantation was Rs. 5,00,000 and the total revenue to date is Rs. 20,52,783 and expenditure Rs. 13,91,926. The surplus is Rs. 6,60,857 so that the net return per acre per annum is Rs. 3-13-0.

PART II—Discussion of problems of Irrigated Plantations

The problem of siting.—The siting of a plantation is not quite as easy a matter as might appear, and involves careful consideration of accessibility, size and shape of area, soil and available water supply. Any mistake made in siting will result in heavy subsequent losses.

Accessibility.—The plantation should be on a railway line and as close as possible to the market where the produce is likely to be consumed.

Size and shape.—10,000 acres are considered the ideal unit from the point of view of management. The shape should be suitable for economic transportation of produce; a jagged boundary line which will increase unnecessarily the lead for the extraction of material is undesirable.

Soil.—Depth is the most important single factor on which depends the future of a plantation. A number of factors which singly or in combination make the soil 'good', are asso-

ciated with depth of soil. Shallow soil must be avoided, as also ground with an uneven surface. It is a mistaken belief that only the poorest type of land should be devoted to plantations as returns are much greater from good land under agriculture. In considering comparative returns, it is necessary to bear in mind that firewood and timber are essential commodities for the community as a whole and prices cannot be allowed to soar high without causing hardship.

Water supply.—A site for a plantation should not be selected at the lower end of a canal system or at the tail of a distributary rather it should be as near as possible to the headworks in order to ensure an adequate supply of water. The command should be good for the rapid distribution of water.

Miscellaneous irrigation problems.

(A) TRENCH IRRIGATION VERSUS FLOODINGS.

In the new plantations started after Changa Manga the layout provides for irrigation by the trench method. This does not mean, however, that trench irrigation versus flooding is a closed question; in fact experimental data are completely wanting to compare the relative advantages of both the methods under varying soil and climatic conditions.

In this connection it is interesting to note that the "deep" irrigation as now practised in Chichawatni is not a simple but a composite method combining features of flood and trench irrigation. On the other hand, in Changa Manga, where after elight decades of flood irrigation a revision of the irrigation system is now being considered. Opposite trends have developed in the irrigation practice aiming at the incorporation of some features of the trench method.

As the reopening of trenches is an expensive item, there is need for scientific investigation of the relative merits of both the methods.

(B) SHALLOW VERSUS DEEP IRRIGATION.

Deep irrigation has undoubtedly improved crops in Chichawatni, but the results must be correlated with local soil conditions and other factors. The deeper the soil the bigger the soil reservoir, and the greater its capacity for holding water. On shallow soils with a sand substratum or hard pan relatively close to the surface, excess irrigation water beyond the retentive capacity of the soil goes to waste. It must not be forgotten that it is easy to blame irrigation for poor crop development when the fault really lies with the soil and *vice versa*. The practical outcome of any irrigation method must be interpreted in terms of depth of soil and other factors.

(C) SHORTAGE OF WATER SUPPLY DURING THE EARLY IRRIGATION SEASON.

Can *shisham* plantations be raised when there is a shortage of water during April and May as in the case of the Sutlej valley project canals? The answer to this question is a clear 'no.' Under the semi desert conditions of the Punjab it has been found impossible to grow *shisham* without early irrigation. The trees do not grow rapidly, and succumb to insect and fungus diseases, so that the high rate of payment for water is not justified.

Water requirements of plantation crops.—To determine the water requirements of plantation crops, co-operative experiments were carried out at Chichawatni and Khanewal under the guidance of the forest research institute, Dehra Dun. Observations based on these experiments show that 3 inch waterings were not so effective as 6 inch waterings. At Chichawatni a 3 foot delta delivered in 6 inch waterings was about the optimum limit of irrigation for average soils, water in excess of this limit being unaccompanied by any significant gain in growth. At Khanewal, the optimum limit was a 2 foot delta. With regard to soils, the conclusions were that for a given delta there was no difference in the development of crops as between average and good or as between *kallar* and bad *kallar* soils. On *kallar* soils an increase in delta was accompanied by a proportionate increase in height growth up to 7 feet, but the application of such a heavy delta was neither feasible nor justified by results.

It must be made clear that the above conclusions cannot be considered as universally applicable. The problem is complicated by variations in soil, rainfall and other climatic factors and is capable of solution, if at all, under a given set of conditions only.

The problem of pure shisham plantations.—Extensive irrigated plantations in the Punjab under varying conditions have brought to light a number of factors adverse to the development of pure *shisham* crops. These include soil, water supply, fungus, insects and natural succession.

Soil.—On *kallar* or sandy soils *shisham* makes a very heavy demand on water but little headway in growth and the resulting crops are open

and patchy. For *kallar* soils *farash* is suitable, and for dry situations, *bakain* and *Prosopis* so that it is necessary to grow mixed crops to suit different soils from the start of a plantation. Under older moribund *shisham* crops, *bakain* and mulberry are introduced as an understorey, the latter being confined only to favourable moisture conditions. In Changa Manga, trials with *Eucalyptus* species have demonstrated their unsuitability for mixture with *shisham* and mulberry which suffer from suppression.

Water supply.—With the limited water supply available for plantations, the introduction of xerophytic species is necessary in the interest of water economy, and the best development of *shisham* stands, which respond to the extra quantity of water thereby made available.

The plantations species in descending order of water requirements are mulberry, *shisham*, *farash*, *bakain* and *Prosopis*. Of these *farash* and *Prosopis* are suitable for original stocking and have been introduced on a large scale under arid conditions. *Bakain* is introduced chiefly by under or interplanting.

Fungus and insects.—Pure crops of *shisham* are particularly susceptible to insect and fungus attacks. The destruction of *shisham* over large areas due to the attack of *Fomes lucidus* has been recorded in various plantations. The *shisham* defoliator, *Plecoptera reflexa* is responsible for serious injury in pure *shisham* stands; the surviving trees unable to complete full vegetative activity due to the repeated loss of leaves, become lanky, malformed and unhealthy. For these reasons, the establishment of mixed stands dominated by *shisham* by introducing suitable species in the lower storey is considered desirable.

Natural succession.—The invasion of *shisham* crops by water borne mulberry in Changa Manga is only one case of the wider problem of succession of light crowned species by shade bearers. It was fortunate for the Punjab that the "successor" species was mulberry which is so much valued by the sports trade. In general, however, it is impossible to name in advance the successor species for plantations growing under different conditions. Under riverain *shisham* crops in the United Provinces, *Holoptelia integrifolia* has been recorded as the aggressor species. In other *shisham* plantations of that province the successor species include *Jaman* (*Eugenia jambolana*), *nim* (*Azadarachta indica*), *Ficus*, spp., *Ehretia* and even mangoes.

Problem of pure farash stands.—Reference has already been made to the tolerance of *farash* to alkali salts (*kallar*) in the soil. In Miranpur, large areas with a high salt content were planted with *farash*. The plants did well for a time, but showed signs of stagnation in growth 3 to 4 years after their establishment, causing large blanks. In Khanewal, compartments in which *shisham* crops were backward were treated as *farash* areas, but as *farash* crops also were poor it was necessary to cut back the stands wholesale, and replant with *shisham*. Alternatively *bakain* was introduced in the lower storey.

Heavy mortality in the originally well stocked *farash* areas long after the period of establishment is of special significance and should be kept in view when planting this species on a large scale.

The problem of control of dub grass (*Dismostadya bipinnata Syn. Erogrostis cynosurvoides*). In plantation crops, the invasion of *dub* grass follows a reduction in the overhead shade caused by mortality among stems owing to insects, fungus or unsuitable soil conditions. The restoration of cover in the overwood by giving more water or strengthening the undergrowth by underplanting has proved effective as remedial measures.

Underplanting.—For underplanting, *bakain*, a species originally regarded as a weed in Changa Manga, has proved almost ideal. Introduced as an understorey it remains there during the first rotation. During the next rotation it joins the overwood and forms a mixture with *shisham* ecologically as well as economically. There is hardly any other species better adapted to fill up grassy blanks. Under more favourable conditions the understorey can be built up with mulberry planted under open *shisham*. Other species tried with the same object include *Rhus lancea*, *Osage orange* etc., but they have not shown any superiority over *bakain* or mulberry.

Interplanting aiming at the early closure of crops and the suppression of grass growth, involves excessive expenditure of water and has not proved satisfactory.

Labour problem.—The Punjab plantations are situated near prosperous canal colonies, with an intensive demand for labour on the fields. The shortage of labour becomes very acute

during the harvest seasons, April-May and October-November. A trained labour force is required for the various plantation works. It is essential to arrange for permanent labour called *beldars* who must reside in the plantations where they get the necessary training for the specialised kinds of jobs they have to do. These labour settlements involve special problems, *viz.*, wages, housing accommodation, and other concessions including land for cultivation, grazing facilities for cattle etc. The terms must be attractive enough for the *beldars* to stay in the plantations. 100 to 200 *beldars* are required for a plantation of 10,000 acres.

Another source of labour is the criminal tribes settlements. The tribesmen are not however considered to be willing or honest workers and often administrative difficulties arise in handling the labour on account of the dual control by the criminal tribes department and the forest department.

Seasonal labour is of great importance during the winter for felling, billeting and the extraction of firewood and timber.

THE TECHNIQUE AND PROBLEMS OF IRRIGATED PLANTATIONS OF THE PUNJAB*

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Irrigated plantations are a highly specialised form of forestry combining silviculture with the economic use of canal water. The Punjab was the pioneer of irrigated plantations in India and the afforestation and conversion of large tracts of semi-desert scrub into a valuable forest estate will perhaps rank as a major achievement of forestry. The plantations formed so far, cover about 50,000 acres, and have considerably eased the situation regarding the fuel supply to the more important towns in the province; they have also proved a great boon to the rural population by providing fuel, fodder, grazing, labour, and wood for their domestic use. The creation of more plantations in time to come, will undoubtedly bring greater prosperity both to the urban and rural populace and give a fillip to the wood industries. Already the Sialkot sports goods industry which is solely dependent on mulberry (*Morus alba*) produced in the Changa Manga plantation has made its mark and acquired a world wide reputation.

The formation of these plantations is a long story, a story full of trials and errors, thrills and disappointments and a multitude of problems, both local and general, with which foresters have been confronted for the last 80 years and which they have tackled with patience, and skill. The subject in its different aspects has been widely written up by various forest officers from time to time since the initial start at Changa Manga in 1866. It was, however, from 1920 onward when some of the younger plantations, *i.e.*, Chichawatni, Khanewal and Daphar came into being that the attention of the Punjab forest department was specially focussed on irrigated plantations. The next decade marked a progress in the development of plantation technique. Various problems were discussed in the two Punjab forest conferences held in 1930 and 1931, and finally a plantation manual embodying the accummulated experience of the past was compiled by S. S. S. Bahadur Singh, P.F.S., and printed in 1932. The manual forms a guide book for the raising and management of irrigated plantations, However, since then many problems have cropped up and it is proposed to discuss in this note these later problems and to review the evolution and working of the present technique. The problems of irrigated plantations chiefly relate to layout, choice of species, method of stocking, tending of crops and lastly, but most important, irrigation. These are dealt with below:—

The layout of the area

The layout of the area consists in its division into compartments, the unit of control in forest management and the layout of the irrigation system. An efficient layout must provide facilities for the extraction of the produce and ensure proper

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irrigation of the area. It needs careful and thorough planning beforehand, for a defective layout introduces a standing handicap in the efficient working of the plantation for all time. Changa Manga, the oldest plantation in the province, is suffering from this handicap, as in the beginning the planning was imperfect owing to lack of experience. The size of the compartments was not fixed, the individual compartments varied from 16 acres to 250 acres. Irrigation facilities also did not receive the attention deserved. The ground was never levelled and the water courses were not well spaced or designed to carry water on a proportionate basis of the area served. Improvements have been carried out from time to time in the light of experience gained but it will never be possible to attain the desired uniformity and regularity in the distribution of the areas served by *khals* (water courses from which water is directly let into an area for irrigation) so essential in the practical control of irrigation, unless the old layout is scrapped.

By the time of the formation of the next plantation (Chichawatni, 1913) greater knowledge regarding the layout had been gained and so a systematic layout was planned. For the areas handed over to the forest department the canal department prepared a contour plan dividing the area into rectangles of 25 acres (1,100′ × 990′); levels were taken 500 ft. apart and recorded in each rectangle to indicate the slope and lie of the land. The general irrigation system was also planned by the canal department, subdividing the area into irrigation *chaks*, *i.e.*, an area commanded by one canal outlet and marking the position of feeder channels indicating the arrangement of the delivery of water into each square. The forest officer had only to complete the inner details consisting of the division of the area into compartments and the layout of the *khals*. and an occasional alteration in the feeder channels to suit the internal layout. For the completion of these inner details 50 acres was considered as a suitable size for a compartment. So two rectangles of 25 acres each formed a compartment bounded by 20 ft. wide roads all round designed to serve both as compartment boundaries and for the stacking and extraction of wood. The irrigation layout was planned as follows:

(1) When a compartment was laid *along* the contour lines its dimensions, were: (*a*) 2,200′ × 990′ or (*b*) 1,980′ × 1,100′. Each compartment was divided into seven equal parts by inserting six *khals*, and the portion between the two *khals* was subdivided into equal parts by making a cross road 10′ wide in the middle. Thus the entire compartment was divided into 12 equal parts and the net width of the blocks (better known as centres) available on either side of the *khals*, for planting, worked out to about 162′ for (*a*) and about 144′ for (*b*) excluding the space taken up by the *khals*, their embankment and the cross roads.

(2) When a compartment was laid *across* the contour lines, it was divided into four parts by means of three *khals* and redivided into six parts by cross roads. The net width of the planting centres in this way came to about 143′ for (*a*) and 162′ for (*b*).

The size of the *khals* was fixed at 3 ft. bed width, 1 ft. depth and 4 ft. top width. A *khal* of these dimensions was calculated to carry a discharge of 4 cusecs (a cusec means one cubic ft. of water passing a definte point, the head of the water course, in one second) which was considered a suitable unit for irrigation. Levelling the area was accomplished by leasing out the plantation for temporary cultivation. The cultivators cleared and levelled the area, raised field crops and annually handed back to the forest department the area required for planting trenches or otherwise, according to the terms of their lease. Some times these also included the planting up of the area.

The above layout was improved upon with further experience. It was felt that the compartment widths, *i.e.*, 990′ to 1,100′ was on the high side for the economical transport of wood, and that the width of planting centres could be reduced with advantage for efficient irrigation. 600 to 700 feet was looked upon as convenient distance for the economical carriage of wood by the labour employed on exploitation. With these ends in view, a revised layout was devised forming compartments of 50 acres by equally dividing 6 rectangles (25 acres each) 1,100 ft. × 900 ft. into 3 parts. This reduced the compartment width from 660 ft. to 733 ft. depending on the lie of the rectangles. The division of compartments for irrigation under this arrangement was as follows:

(1) When the compartment was laid *along* the contour lines, dimensions (*a*) 2,970 ft × 733 ft. 4 inches, or (*b*) 3,300 ft. × 660 ft. Each compartment was divided into 16 parts by 15 *khals* and redivided into 30 parts by cross

roads with the width of the planting centres about 81 ft. for (*a*) and 92 ft. for (*b*).

(2) When the compartment was laid *across* the contour lines, it was divided into (*a*) 8 parts by 4 *khals* and cross road and (*b*) 6 parts by 3 *khals* and cross roads. Thus the width of planting centres came to about 73 ft. and 91 ft. respectively. With the reduced centre widths the size of the *khal* has also been reduced to a carrying capacity of $1\frac{1}{2}$ to 2 cusecs discharge.

The revised layout generally finds favour to-day, as it provides for a great efficiency and economy in the use of water. Only one case is open to some objection, and that is when the rectangles are so placed that the dimensions of a 50 acre compartment work out to 3,300′ × 660′. In this case, the *khals* when laid across the contour have to be 3,300′ long which is rather to long a lead. But this could be remedied by dividing the compartments into two halves lengthwise and inserting a feeder channel in the middle so as to reduce the *khal* length to 1,650′. The current opinion on the subject of layout may be summed up as follows:

(*i*) The most convenient size for a plantation is 10,000 acres. The best size of compartments 25 to 50 acres, with a width from 600′ to 700′.

(*ii*) The width of compartment roads, *i.e.* 20′, is considered insufficient for the extraction of produce by a loco tramway, as it does not provide enougn space both for the track and for stacking timber and firewood. In Changa Manga where mechanical transport is used, produce has to be stacked in the compartment alongside the roads. This defers the planting up of that ground, until the wood is removed. In a new layout this could be obviated without adding to the road width or using any additional space. All that is needed is to run a road 10′ to 12′ wide on either side of the compartment road bounded by *pasels* (link trenches). The trenches should end in the inner *pasel* except for a few suitably spaced which should extend to the outer *pasel* in order to establish a connection with the inner *pasel* for drawing water. Thus both the *pasels* could be planted up and yet the intervening space would be available for stacking purposes. With this arrangement the roads could always be kept clear. The plants along the *pasels* if damaged in the course of removal of firewood could be cut back to obtain fresh coppice.

(*iii*) The layout should be such that *khals* should run across the contour so that their bed slopes follow the natural slope of the ground.

(*iv*) The water carrying capacity of the *khals* should be limited to what one man can manage. About two cusecs would be ideal and in no case more than four.

(*v*) The length of the *khals* should not ordinarily exceed 2,000′ to 2,500′. The *khals* have to be frequently headed up and their embankments cut at intervals in order to let in water to the area at their command. Thus their efficiency is lowered through silting up etc., which happens, if they are too long.

(*vi*) The width of the planting centres should not exceed 100′ in the case of two cusecs and smaller *khals*, but may be up to 150′ or so for four cusec *khals*.

(*vii*) The size of an irrigation *chak* should not exceed 500 acres, so that a regeneration area can be concentrated on an outlet.

Choice of species

Shisham (*Dalbergia sissoo*) is the best alround species for the Punjab plains and was selected for the plantation at the time of the initial start in Changa Manga in 1866. From the very beginning, however, no opportunity was lost in investigating the possibility of success with other species. During the formation period of the Changa Manga plantation (1866—82) a fairly large number of likely species were tried, *e.g.* mulberry (*Morus alba*) and (*M. indica*) *bakain* (*Melia azedarach*), *farash* (*Tamarix articulata*), willows (*Salix babylonica* and *S. tetrasperma*), *jand* (*Prosopis spicigera*), *phulahi* (*Acacia modesta*), *kikar* (*Acacia arabica*), *toon* (*Cedrela toona*), *ber* (*Zizyphus jujuba*), *Acacia farnesiana A. leucophloea*, *A. rupestris*, *A. melanoxylon*, *Tecome undulata*, *Eucalyptus*, *Schleichera*, *Gmelina Kydia* and *Anogeissus* species, Carob (*Ceratonis siliqua*) *Platanus orientalis*, *Catalpa bignonicides* and *Prosopis glandulosa* etc.

Of these, mulberry did remarkably well with *bakain* and *farash* as next best, the latter in depressions and on bad soil only. Willows which were largely planted along the water courses grew luxuriantly but were found short-lived and had to be felled at about 12 years of age. The other species failed generally through frost, drought and other causes though stray specimens of most of them are still found here and there in the plantation, on road sides, and in the bungalow compound.

Shisham remained the principal species, but not for long. The spontaneous appearance of mulberry was first noticed in 1876 and the species was sown in mixture with *shisham* over 770 acres during the next two years. With this start and the wide dispersion of seed through the combined agencies of irrigation water, wind, birds and animals, mulberry spread rapidly and started gaining ground over *shisham*. By the beginning of the century mulberry had established a strong hold and threatened the existence of the *shisham* creating an alarming situation. No measures, however drastic, taken to assist the *shisham* proved helpful. The trouble was further aggravated by the appearance of fungus (*Fomes lucidus*) on *shisham* immediately following the invasion of the mulberry. The attack was virulent all over the plantation resulting in a heavy mortality, particularly amongst the old *shisham* standards. The two causes combined reduced the *shisham* to second place as regards stocking. So much so, that at present over 80 per cent. of the growing stock consists of mulberry. The position, though alarming at first, was however accepted with gratitude in the light of later happenings. Mulberry established a market for itself in the sports industry and became a species of high economic value. It was also found to give a better yield per acre, compared with pure *shisham*. The fame of Changa Manga was the fame of the mulberry. But the mulberry also had its problems. It was short-lived, shallow rooted, sensitive to drought and under the condition prevailing in the west Punjab, it required some nurse and covering for a good start. In short, a pure stand of mulberry was inadvisable and some mixture and overhead covering was essential. Accordingly fresh investigations were directed towards finding suitable alternative species for mixture and to serve as standards. *Albizzia lebbek*, *Gmeline arborea*, *Terminalia tomentosa*, *T. arjuna*, *Bischofia javanica*, *Cedrela toona*, *Ougeinia dalbergioides*, *Pistacia integerrima* and *Piptadenia oudhensis* were tried for standards but failed. They were mostly killed by frost or suppressed by the mulberry. A number of eucalyptus species, *e.g.* *E. rostrata*, *E. tereticornis*, *E. siderophloia*, *E. rudis*, *E. paniculata*, *E. crebra*, *E. melanophloea* and *E. citriodora* were also tried. *Eucalyptus rostrata* showed some promise and further experiments to devise the best method of establishing the species on a commercial scale were started in 1923-24. A technique of raising the species in small bottomless pots and pot planting in the forest was soon developed and between 1926 and 1930 thousands of *E. rostrata* plants were introduced in a number of compartments in the plantation. The species did well and some fine blocks and avenues of eucalyptus are still seen in the plantation, but considering all the pros and cons, its wide cultivation was ruled out. Firstly, it required much water which was not available. Secondly, the cost of the initial planting and upkeep in its early stages was excessive. Thirdly, owing to it being a much faster grown than mulberry and *shisham*, management was likely to be complicated. When coppiced with the rest of the crop (compartment 69 Changa Manga) eucalyptus was entirely suppressed, and when felled in an intermediate stage with thinnings (compt. 56), it did not coppice well, leaving large gaps in the crop. And lastly, it is poor fuel wood and does not yield good timber. After all these experiments, opinion reverted to finding ways and means of maintaining a reasonable proportion of *shisham* in the mixture. With this end in view, a special amendment to the prescriptions of the current working plan for Changa Manga was issued by the chief conservator of forests, in 1939, to the effect that 20′ wide strips at intervals of 100′ from centre to centre should be marked in the area under regeneration each year and *shisham* favoured in these strips by planting and carrying out necessary cultural operations. This even was considered an insufficient measure for securing a good proportion of *shisham* in the crop. The current practice is to plant up the entire coupe of the year with *shisham* stumps (10′×6′), planting being fairly cheap. The method combined with weeding and cleaning has given fair results but the position is not entirely satisfactory. It is suspected that flood irrigation and three rotations of coppice have so altered the factors of the locality that it is getting more and more unsuitable for *shisham*. Intensive soil studies may give some clue.

As regards the other plantations *shisham* was the species used for the original stocking, but unlike Changa Manga their troubles started during the formation period, particularly in the plantations situated in the Mongomery and Multan districts, *i.e.* Chichawatni, Khanewal, Miranpur, Arifwala and Dipalpur. Problems of an altogether different nature had to be faced owning to soil variations combined with the peculiar conditions of the water supply in some of these plantations. The soil is hardly

of uniform composition in any one of these plantations. Large areas of *kallar* (saline) soil were present in all the plantations. With the exception of Chichawatni, shallow sandy loam (soil 1′ to 8′ deep) overlying a deep stratum of course sand is of common occurrence in all these plantations. In Miranpur, Arifwala and Dipalpur plantations on the Sutlej valley project a regular and sufficient water supply was only available for 3 months—July, August and September. During April to June the supply was small and uncertain. This meant postponing stocking to July with the result that the plants had a short growing season in their first year and were ill-equipped to face the coming hot weather, where again there was uncertainty of early irrigation. In consequence, the stocking obtained with *shisham* in all these plantations was very irregular, showing large variations in vigour, quality and density. Except on good soil, *shisham* generally formed an open crop indicating the necessity for a mixture. Mulberry appeared naturally and was also extensively introduced by underplanting in young crops after the first thinning at the age of five but its success was limited to favourable conditions of soil and water supply. *Shisham* refused to grow into a crop on *kallar* and shallow soils even with extra watering. Heavy irrigations administered to areas with incomplete stocking brought in some cases another evil, *i.e. dub* grass (*Eragrostis cynosuroides*) which filled up the blanks. Its luxuriant growth during the irrigation season and its matted root system created an additional problem for establishing any tree cover over such areas. The trouble being so acute that these areas acquired a distinct identity of their own and came to be known as '*dub* areas.' The trouble did not rest there. The backward areas in Chichawatni, Khanewal, Miranpur and elsewhere were visited by the *shisham* leaf defoliator (*Plecoptera reflexa*) which made its first appearance in 1919. The defoliation commenced when the trees put out their new leaves in April and May and lasted throughout the hot weather. To sum up, the following are the problems for the younger plantations:

(*a*) A suitable species for the under and interplanting with *shisham*,

(*b*) a species for *kallar* and shallow sandy soils,

(*c*) a species better than *shisham* for the plantations on the Sutlej valley project where the regular water supply only commences in July and

(*d*) a species for *dub* areas and a method for the eradication of *dub* grass.

All these problems are still awaiting solution. Work done by the territorial divisions was supplemented by opening a research station at Chichawatni in 1930. Some of the species tried are given below:

(*i*) For under and interplanting *shisham*.—*Bakain* (*Melia azedarach*), *Naclura aurantiaca*, *Celtis eriocarpa*, *Albizzia lebbek*, *Acacia procera*, *Butea frondosa*, *Bombax malabaricum*, *Cordia myxa*, etc.

(*ii*) For *kallar* and shallow soils and other objects.—*Farash*, *bakain*, *Acacia Catechu*, *A. arabica*, *A. leucophloea*, *A. modesta*, *A. senegal*, *A. farnesiana* (local and American forms) *Prosopis juliflora*.

(*iii*) For *dub* areas.—*Ipomea carnea*, *Adhatoda vasica* and *Rhus lancia* for suppressing *dub* grass and *bakain*, *Schinus terebinthifolius Cordia myxa* and some of the species under (*ii*) above for planting.

A number of exotics are also under trial in the Chichawatni research station.

Of all the species *bakain* (*Melia azedarach*) gave the best results under varied conditions and it is now used on a large scale for filling up gaps in *shisham* crops. The under and interplanting of *bakain* with *shisham* is a routine practice in Khanewal, Chichawatni and elsewhere though *bakain* has been found brittle and liable to wind break. On *kallar* soil *farash* (*Tamarix articulata*) gave good results but it formed an open crop. It is used for stocking *kallar* areas and also for planting in mixture with *shisham* for doubtful areas, so that if *shisham* failed, *farash* will be there and if it is succeeded, *farash* could be removed in thinnings. In the Khanewal plantation alone an area of 1870 acres of poor *shisham* crop abandoned in 1928 has been stocked with *farash*.

Most of the other species either failed or were found to be too slow growing or tender. Mesquite (*prosopis juliflora*) gave some success on high ground and in poor areas but it did not form a crop of any value. *Celtis eriocarpa* and *Acacia farnesiana* (the American frost hardy form) gave indications of their use for underplanting and for filling up gaps in poor soils. But not much is known of these species.

General opinion based on experience gained so far with the trial of a large number of species

under varied conditions of soil and climate is as follows :

(*i*) That *shisham* is the best species for original stocking but a mixed crop is more desirable. Mulberry and *bakain* are the most suitable species for mixing with *shisham*. The cultivation of mulberry should be restricted to a good deep soil and with favourable conditions of the water supply. Mulberry is unsuitable for the extreme arid conditions prevailing in the plantations of Multan district. *Bakain* is very liable to wind break and it would be inadvisable to plant it in mixture on the outer edges of a plantation.

(*ii*) That *farash* is the best species for *kallar* soil unless something could be done to wash away the salts and improve the soil. *Farash*, however, does not form a closed crop.

(*iii*) That in the existing plantations and with our present knowledge, where *shisham* will not form a closed crop, no other species will.

Method of stocking

Changa Manga, (the oldest plantation), after ploughing and ridging, was first stocked by broadcast sowings of *shisham* followed by trench sowing. It was only by accident that the trench system was discovered. Its origin is interesting and is described by Mr. Holland in his note on the formation of plantations as follows :

" The original intention was merely to dig up the soil to the depth of one foot but as the labour could not be trusted to dig to this depth without constant supervision the soil was removed along lines one foot wide and one foot deep and after inspection, the soil was thrown back into the trenches and the seed sown on the prepared earth. The trench so formed was not completely filled and formed a channel to conduct water."

At first the seed was sown on the ridges of earth dug from the trenches, but later the present method of sowing along the cleared trench berms about 4″ to 6″ away from the edge was evolved. The method of "stump" planting (cuttings obtained from 1 to 2 years old nursery stock by pruning both the stem and the root, leaving $1\frac{1}{2}''$ to 2″ of the stem and 9″ to 14″ of the tap root and the cutting of all the lateral roots) was introduced for the first time in 1922. It owed its origin to the necessity for economy in the use of water, the supply of which was limited. Crops raised by direct sowings were found to make a very heavy demand on water in the initial stage, required intensive and expensive tending, and became patchy on bad soil. Stump planting gave all round better results, was easier, cheaper and far more economical in the use of water in the early stages. For some time both the methods of stocking *i.e.*, direct sowings and stump planting remained in use, but stump planting soon established its merit and from 1927 onwards it has been more or less exclusively used for planting new areas, sowings having been restricted to nurseries only. There are no two opinions as to the economy and efficiency of stump planting for raising *shisham*. The method has since been standardised and a nursery technique has been evolved (*Punjab forest records*, Vol. 1, No. 10, 1942).

As regards the other species of plantation of importance, stocking is done as follows :

Mulberry.—Both by sowing and stump-planting. Stumps are generally used for underplanting. The species is introduced as an understorey in a *shisham* crop after the first thinning at the age of five. In Changa Manga abundant natural seedlings spring up in the regeneration areas as a result of flood watering especially in the second year, when some covering is available. In patches where mulberry is deficient, the mere scattering of seed with the irrigation, serves the purpose.

Bakain.—By stump-planting and transplanting. Stumps do well if planted early in the season. Transplants (6″ to 12)″ with balls of earth can be planted with success up to August.

Farash.—By shoot cuttings, preferably of the blue variety, 12″ to 15″ long and of thumb thickness.

Eucalyptus spp.—By pot-planting. The plants are raised in small bottomless pots (6″ deep and 3″ to 4″ diameter). In a month's time the plants are big enough to be planted which is done with the pot intact. The pots are withdrawn later.

Prosopis juliflora.—By transplanting. Transplants 1′ to 2′ high with balls of earth are used. When lifting the plants from the nursery, the roots are severed with a sharp instrument.

The tending of crops.—The operations to be discussed here are thinnings and early clean-

ings. Cleanings at the end of the first year or early in the second year have for their object the reduction of the number of coppice shoots to two or three per stool and to space the crop for better growth. The subject is controversial and the operation is not regularly carried out in all plantations. It has lately been started in Chichawatni, Daphar and Changa Manga plantations. The cost on cleanings comes to approximately Rs. 5 per acre (Chichawatni). The position of Changa Manga is different where the growing stock is mostly mulberry. Here the cleanings are an entirely cultural operations, *viz.*, to favour the *shisham* and to save it from suppression by the mulberry in early life, so as to secure a reasonable proportion of *shisham* in the mixture, and secondly to favour the natural mulberry for timber production against the coppice. Further research on cleanings is necessary.

Thinnings

In the Changa Manga plantation three thinnings are done in the 6th, 10th and 14th years in a rotation of 18 years. In other plantations where the growing stock is mainly *shisham*, two thinnings are done, in the 6th and 11th years in a rotation of 18 to 20 years. In Changa Manga, the third thinning is carried out in order to increase the production of mulberry timber. The necessity of carrying out thinnings after every five years or so is generally recognised but the intensity of thinnings is a debatable point. In *shisham* crops in new plantations the first thinning is almost a mechanical operation, a good spacing is obtained by removing the alternate stems. But the second thinning requires more care and thought. A 'C' grade thinning is generally prescribed or aimed at, but in practice the standard varies from place to place.

Changa Manga with its preponderance of mulberry and irregular stocking has a different problem. Here all the three thinnings are a complicated affair due to the multiplicity of points at issue, *i.e.*, the regulation of the *shisham* and mulberry mixture, earmarking *shisham* trees for standards, and ensuring a better outturn of mulberry timber. It is felt that the trend of thinnings here has been on the heavy side and it has contributed to a drop in the total production per acre in the current rotation as will be discussed hereafter. Mulberry in Changa Manga is a heavy crowned species, and given adequate irrigation, the canopy soon closes, even after heavy openings. This has perhaps been the temptation to make heavy thinnings. The thinning problem needs a thorough investigation with reference to the objects of management and the requirements of the species.

Irrigation

Water is the life of a plantation but its supply is limited to a 3′ to 4′ delta (depth per acre for the season April to October) for different plantations and that not always guaranteed. The cost of irrigation including water rate paid to the canal department (Rs. 4 to Rs. 5-8-0 per acre per annum) works out to more than 50% of the total cost of the formation of a plantation. In consideration of this heavy cost, coupled with the uncertainty of supplies, the question of economical use of water is of fundamental importance and has been the subject of constant study from the very beginning. Two systems of irrigation are in vogue, *viz.*, the flood system of Changa Manga, and the trench system practised in the remaining six plantations. The latter system is the logical outcome of the experience gained at Changa Manga and the general advancement of knowledge on irrigation with the passage of time. The flood system of Changa Manga has also undergone a considerable change. In the old days it meant throwing bunds across a big channel and letting in the water over an extensive area, which it took days to irrigate and absorb. As the plantation developed difficulties multiplied and it became difficult to give even one irrigation in the season to the area planted with the available supply of water. This led to the introduction of more channels, and the divisions of the area into smaller blocks for the easy spread of the water. Through gradual improvements the layout under the flood system has been brought as close to the trench system as possible. But the trench system is recognised to be the best to ensure the rapid and even spread of the water. Its layout has already been discussed. In the actual process of working, water is carried from the main outlets on the canal to the feeder channels, and then on to the *khals* which are headed up at every 400′ to 500′ by throwing earth bunds across and the water is then let into the plots on either side of the *khal* by making cuts (known as *takkies*) at every 100′ to 120′. All the trenches in a plot are connected by means of a link trench called the *pasel* running all round the plot. The *khal* delivers the water into the *pasel* which, in turn, feeds the trenches. Each *takki* irrigates about 10 to 12 trenches at a time, depending on the

discharge or quantity of water running in the *khal*. As each area is sufficiently watered (occular observations), it is cut off and irrigation proceeds further. Opinions on the dosage of water in one irrigation have varied. The plantation manual harped on the advantages of shallow and repeated irrigations. This system remained in force for some time, particularly in Chichawatni, the home of the shallow irrigation theory. It is of interest to record that the so-called shallow or deep irrigation did not mean in practice the delivery of a measured quantity of water in each irrigation. The shallow irrigation was achieved by running water in 1′ wide, 6″ deep trenches and cutting off the supply when the trenches were just full. For deep irrigation, the size of the trenches was 12″×12″ and water was retained in the plot for a longer period till the trenches overflowed and were thoroughly soaked. It was estimated that shallow irrigation absorbed 3″ to 4″ depth per watering against 6″ and over for deep irrigation. However, the theory formed the subject of research from 1931 to 1935. A properly replicated experiment was laid out in Chichawatni plantation on sandy loam soil to test the comparative growth of *shisham* under 3′ and 4′ depth of water delivered under the shallow and deep irrigation methods. A detailed account of the experiment is available in the *Punjab forest records*, Vol. I, No. 4, 1937. The conclusions were that irrigation in 6″ depth per watering gave definitely superior results both in height and diameter growth of the crop for a given delta (total depth of water, *i.e.*, 3′ and 4′) in comparison with oft-repeated shallow irrigations in 3″ depth.

The above results supplemented and backed by observation and experience of individual plantation officers have led to the practice of delivery of moderately deep irrigations which are considered generally suitable. The modern thought, however, does not rest at that. It is realised that a stage has come when irrigation (both frequency and total depth for the season) should be governed by the requirements of the species with respect to the soil, locality and crop. This opens a fresh field for research. It involves on the one hand finding ways and means by which a definite quantity of water can be given to each area at will, and on the other a detailed study of the behaviour of water in the different kinds of soil met within the plantations. As for the first, at present both under the flood and the trench systems, the control of water lies at the canal outlet head, where we know what definite quantity of water is passing. There are no ready ways and means of giving a desired depth of water to a particular area. One has got to go through a laborious process of measuring the discharge of each *khal* daily and then regulating the time for a given depth which is hardly practicable on a large scale. Our records of delta (depth of water per acre) delivered to a crop are based on the total quantity of water received in an outlet at the canal head on any one day and the total area covered for the day regardless of inner variations. The object of regulating the depth of water over each compartment and its subdivision can only be attained if the control of the water is moved to the *khals*. Once the discharge of a *khal i.e.* the quantity of water passing through it in 24 hours is fixed, it is a matter of simple arithmetic to work the time required for giving the desired depth to the area at its command. For a day cusec, *i.e.* a cubic foot of water per second running for 24 hours equals 86,400 c.ft. of water and it gives a depth of one foot over two acres. On this basis, tables could be prepared for ready reference showing the time required for a unit depth say one foot for field use. It, however, requires careful planting to synchronize the time factor for all the *khals* on an outlet. The science of irrigation has made a rapid advance in the last two decades and it is now possible to have the type of control desired. The irrigation engineers can design heads to give the minutest discharge on any water course within a reasonable measure of accuracy. A beginning on these lines has recently been made in the Changa Manga plantation.

The water requirements of the plantation species are closely allied with the soil and the behaviour of water when applied in varying depths. The depth of water required and the frequency of irrigations cannot be determined without a thorough knowledge of the movements of water in the soil, loss by evaporation and the quantity available for plant use. No economical use of water is possible without this knowledge. The time and money spent on these investigations will be well worthwhile in order to establish a scientific basis of sound and suitable irrigation. Preliminary work done in this line in Chichawatni plantation (*Punjab forest records*, Vol. I, No. 4 1937) has shown that for clayey loam soil, there was no gain in the height growth of a young *shisham* crop

by increasing the water supply from 3′ to 4′, 5′ or 6′ depth per year. In the case of *kallar* soil, however, a delta of 7′ gave significantly better growth but additional water above a 7′ depth was not accompanied by any gain.

Current Problems

From the foregoing account it will be seen that the problems faced so far are the problems of the formation period of the plantations. That period has passed although there still remain some problems unsolved; yet it can be said that with time and experience a technique has been evolved under which the present generation of foresters can with confidence raise more plantations in the province, if they are given an adequate water supply and a reasonably fertile soil capable of bearing a tree crop. Plantation work has now entered the second phase involving problems of a different and, perhaps more interesting nature. One of the questions is that of the improvement and maintenance of a sustained yield. Troubles in this respect have already begun to appear in Changa Manga. This plantation entered its fourth rotation in 1936-37. The yield per acre had showed a steady rise in the first three rotations, possibly on account of the invasion of the mulberry and the gradual improvement of the soil. But in this the fourth rotation there has been a considerable drop in the yield. For final fellings, the working plan estimated an annual outturn of 3,675 c.ft. stacked firewood per acre based on the average outturn per acre in the 3rd rotation. Against that the actual outturn of firewood per acre for the 9 years, 1936-37 to 1944-45, has been 2,347 c.ft. stacked. Some extensions have been made to the plantation between 1921 and 1928 and some of these areas in their first rotation were felled in this 9 years period. Excluding them, the average outturn for the old areas came to 2,679 c.ft. stacked per acre *i.e.,* a drop of about 27 per cent. on the working plan estimate. A drop of about 20 per cent. was experienced in the outturn of *shisham* timber. There was some rise in the yield of mulberry timber but that could be largely accounted for by the extraction of low grade timber to meet the increased war demand in recent years.

In the writer's opinion the drop in the yield is closely associated with the irrigation and the silviculture of the plantation as follows:

Irrigation.—Changa Manga plantation is situated at the tail end of the main branch lower of the Upper Bari Doab canal and it is irrigated on spare water with no guarantee for any minimum supply during the season. Ordinarily the canal department promised to supply during April to June water sufficient to give a depth of $2\frac{1}{2}'$ over the planted area. The supply falls short in a dry year when the canal runs low and the plantation suffers from drought. Mulberry being a shallow rooted species is very sensitive to drought and suffers badly from its effect. In the drought of 1920 the loss was estimated at 30 lac c.ft. stacked firewood apart from incalculable loss of increment. Similarly drought brought a calamity in the years 1940-41, the effects of which are still visible in the plantations. The exploitation of dry trees has been an annual affair since 1942. The havoc wrought by a low water supply could be considerably reduced with control of irrigation and proper arrangements for the even distribution of water. But through present lack of control, one irrigation absorbs anything up to a 2′ delta or even more and in a year of low supply, the first irrigation of the plantation can hardly be carried out by the end of June. The areas which get late irrigation suffer a severe setback apart from the opening out of the crop through mortality, finally resulting in a drop in the yield. The type of desired control of irrigation has already been discussed in a foregoing paragraph and need not be repeated here. In addition to arrangements for the controlled distribution of water, it may be necessary to concentrate on raising a good mulberry crop on a smaller area commensurate with the supply of water in a bad year.

Silviculture.—The method of regeneration and tending the crop has an important bearing on production. Complete stocking is the first essential. Under the present method of regeneration the area is trenched and planted up with *shisham* stumps. Mulberry comes up naturally, three weedings are done in the first year to help the stump plants and the natural reproduction. Cleanings have been started recently, otherwise beyond the replacement of failures in the second year no operation was done in the past until the crop was due for its first thinning in the 6th year. The young crop in the regeneration area therefore consists of coppice shoots from 1 to 3 rotation old stumps, natural mulberry and *shisham, shisham* root suckers, and stump plants. A good stocking is usually obtained in the first year if the area received close attention, but density

is apt to be reduced in the following two years. The coppice shoots are liable to spread out and suppress the stump plants. Natural mulberry and *shisham* suckers and stumps only make headway in the intervening space between the coppice clumps and beyond the range of suppression by the coppice. Thus the resulting crop may not be as dense as is desired, although to all outward appearances the stocking looks complete owing to the heavy spread of the coppice clumps. It was, therefore, obvious that a change in the method of regeneration was needed to obtain good stocking. Either the coppice regeneration will have to be done away with or effective cultural operations will have to be carried out in favour of natural reproduction, suckers and stumps at the expense of the coppice. Coppice may only be retained where the other forms of regeneration are absent, and the coppice and the coppice shoots from a stool thinned in the first year.

Proper tending of the crops was the next important factor governing production. In Changa Manga, the intensity of the thinnings was originally light. Slightly heavier thinnings were advocated in 1927-28, but in the absence of a definite standard to go by, the practice gradually developed into a heavier intensity than was desirable, more so due to the fact that mulberry developed a heavy crown with irrigation after a bigger opening and the canopy joined up quickly. It is believed that if the two thinnings were light and the third thinning heavy, it would be more suitable. *Shisham* trees fit for standards would be selected at the time of the first thinnings and given a wider opening. This treatment is likely to benefit both the production of *shisham* timber, firewood and good clean mulberry timber. The correct intensity of the operations will have to be determined by research.

So much for firewood. The reduction in the yield of *shisham* timber is attributed partly to heavy mortality of *shisham* standards on account of severe fungus attack in the past, and partly to defective prescriptions of the working plans. The working plans merely prescribed the retention of fifteen standards per acre which were to be felled after three rotations of coppice. For a sustained yield it was essential to have a proper proportion of standards of the three age classes spread over the area. To make it clear, after having retained fifteen standards per acre in the first rotation, it will be necessary to cut out and replace ten in the second rotation and so on, so that five mature standards per acre will be available at every rotation. In the absence of this provision some rotations have to go blank or depend on timber available from chance replacements of casualties.

CONVOCATION OF THE INDIAN FOREST RANGER COLLEGE, DEHRA DUN

The Convocation of the Indian Forest Ranger College was held in the Convocation Hall of the Forest Research Institute, Dehra Dun, on the 31st March 1945.

In welcoming Mr. A. P. F. Hamilton, O.B.E., M.C., I.F.S., Inspector-General of Forests, Mr. C. E. Simmons, President, Forest Research Institute and Colleges, said :

"Mr. Hamilton, Director of Indian Forest Ranger College, Ladies and Gentlemen :

On behalf of all of us I should like to thank Mr. Hamilton, our Inspector-General of Forests, for so kindly consenting to preside at the convocation and to extend a welcome to the new students, who have come to join the College.

The Convocation hall has been placed at the disposal of the 136 Indian General Hospital for the duration of the war for the use of sick and wounded soldiers and I am indebted to Col. Baliga, the Commandant, for allowing us to use the hall for to-day's ceremony.

You will be hearing from the Director of the College a full account of the work of the year and be given information regarding the outgoing students. It is, however, customary on these occasions for the President of the Forest Research Institute and Colleges to make some remarks of a general character. I do not intend to detain you long.

The convocation, which we attend to-day, is, I think rather a special one, in that the end of the war is not far distant and the time has come to look forward to a period of reconstruction and post-war development.

Post-war planning locms largely before us and I may perhaps be permitted to remind you that this vast sub-continent is essentially

an agricultural country. While no one would deny the desirability of expanding industry and developing it on scientific lines, it must not be forgotten that, even when industrial expansion has taken place, the majority of the people of India will still be dependent on the land for their livelihood and well-being.

Sir Herbert Howard in his note *Post-War Forest Policy for India* pointed out some of the disadvantages, under which the rural population is condemned to live, because the percentage of land under forest is below what is considered the minimum necessary for a country essentially agricultural in character, and because our forests are to a large degree concentrated in localities inaccessible to the agricultural classes with their relatively limited radius of movement. There are many extensive areas in India without forests, from which villagers could get their requirements of small timber for houses, agricultural implements, fencing etc. and their firewood, so necessary for a flourishing countryside.

Briefly post-war forest policy aims at a very considerable increase in the forest area and the creation of "village forests" from which the agricultural classes can obtain their supplies of essential forest produce at reasonable rates.

No programme of forest expansion can be put into operation without a corresponding increase in the number of trained foresters, both gazetted officers and forest rangers. It takes two years to train a forest officer in the theory and practice of his profession and another two or three years in a forest division, before it can be said that his education is complete, if indeed a forest officer's training ever really finishes. The need to expand the cadres of the forest services in the provinces and states has been foreseen and, in order to meet the increasing demand for seats at the forest colleges at Dehra Dun, Government of India have decided to provide additional facilities for training, aiming at doubling the output of each college.

So far as the Indian Forest Ranger College is concerned, this means an increase from about 39 trained rangers to 75 each year. The students for the additional classes have not yet arrived, because the new hostels are not yet quite ready and the other arrangements not quite complete. They will, however, arrive before the end of this April.

Two years ago the outgoing students were reminded of the part they would be called upon to play in winning the war, but we were told that the period of reconstruction would follow victory. I would like, if I may, to say a few words on one of the most important aspects of a forest ranger's work in this post-war period.

Country people all over the world, and nowhere I think more so than in India, are extremely conservative and instinctively fight shy of any proposals, which involve a change in habits and long established customs, until they are convinced of the need for such changes and of the benefits which may be expected from them.

Custom and, I regret to say, in many cases economic difficulties lead villagers to do things which are an anathema to the trained forester—things we call forest offences. In dealing with the problem of creating village forests it will be the forest ranger, even more than the divisional forest officer, who will be in close contact with the local people, and it is with regard to his relationship with the villagers that I would like to say something.

Experience has, I think, invariably shown that attempts to stop forest offences with all the full rigour of the law fail to produce the desired results, breeding antagonism, resentment and suspicion. The reason is, of course that the villager has not been sufficiently educated in the forest sense fully to appreciate the position. He has not had the advantage of training at the Forest Ranger College. One of the duties of the forest ranger will therefore be to pass on something of what he has been taught here.

Those to whom we say good-bye to-day will be a vanguard of many others, who are to be trained at the Indian Forest Ranger College, which was developed from the original forest school established at Dehra Dun as long ago as 1878. The College has a long and honourable tradition, which I am sure the outgoing students will do everything to maintain. What I would say to them is "Do everything possible to establish those happy relations with the villagers, which are so necessary for success and set up an example for those who come after."

I regret to say we have to bid farewell to Mr. Ranganathan, who has been director of the college for the last seven years. I have to thank him for the very efficient manner in which he has always carried out his duties. Being a director of the college does not consist

merely in giving instruction in the lecture room and on tour and I wish particularly to thank him for the personal interest he has taken in the students and their college life.

Students, who pass out from the college, I know take away with them very pleasant memories, and they owe a very great debt of gratitude to Mr. Ranganathan. I am quite sure they would wish me to thank him for all the many things he has done for them and in this I naturally include those students, who received their certificates in former years.

We also have to say good-bye to Mr. Starte, who after retirement as a conservator of forests in Bombay, consented to help us as an instructor during the last three years. His wide experience acquired during a long and distinguished career as a forest officer has been a most valuable asset. Like the director he has always shown a personal interest in the well-being and happiness of the students. To him also the thanks of myself and the students are due. Mr. Harrison, Lecturer in Engineering and Surveying, will be leaving us very shortly after six and a half years; during which he has taught the students of both the colleges. He originally joined the Forest Engineering Service and it is hardly necessary for me to point out the advantages to the colleges of having a lecturer, who has specialised in this branch of engineering.

Mr. Harrison has, I am glad to say, found time before going on leave preparatory to retirement, to bring out a very practical manual of surveying as a college text book. Even though we must in future do without his services, he has at any rate left us a very valuable work, which will be appreciated by future students at the colleges. Needless to say Mr. Harrison like all the instructional staff is keenly interested in the students and takes every opportunity of helping them and doing the many little things, which go so far to make a happy college.

I would also like to thank Mrs. Ranganathan and Mrs. Starte for every thing they have done for the students. I am quite sure that I express the feelings of all of us when I wish Mr. and Mrs. Ranganathan, Mr. and Mrs. Starte and Mr. Harrison all that they would wish themselves wherever their futures may lie.

I now ask the Director, Indian Forest Ranger College to read his annual report."

The Director presented the following report :

"Mr. Hamilton, Mr. Simmons, Ladies and gentlemen :

May I be permitted to associate the staff and students of the Indian Forest Ranger College with the welcome extended to Mr. Hamilton by our President. Like many of his predecessors, Mr. Hamilton is an old member of the staff of the college. It is a happy chance that the first public function at which he presides as Inspector-General of Forests should be the convocation of the old college.

I intend to make this a short speech. There is little that I should like to add to or amend in what I have said on similar occasions before, and I will not weary you by going over the same ground again. This is the last time that I shall make a convocation speech; so perhaps you will allow me to strike a personal note. I have had the privilege of being Director of the Indian Forest Ranger College for seven years, which is, when you come to think of it, a large slice of one's official life. When I took charge of the college in April, 1938, admissions were being made once in two years. There was thus only one class in residence, and the teaching staff consisted of Mr. Madan and myself. At that time we were not quite certain whether we should be able to continue our courses without a break. We have come a long way since those days. In 1942 we reverted to annual admissions and increased our staff accordingly. We extended our playing field and instituted a common mess. And now in 1945 we are about to expand still further and overflow into New Forest. During these seven years I find I have been concerned in the training of no fewer than 210 rangers from all parts of the country. When I reflect that this number represents about 20 per cent. of the cadre of rangers for the whole of India, I fear I may have much to answer for in the future management of our forests.

When the outgoing class was first formed in April, 1943, it consisted of 35 students. Very soon after joining the college, an Assam student was taken seriously ill and died in the Coronation Hospital in May 1943. This vacancy was filled by a student from Chamba. One of the Punjab students secured a commission and left for the Indian Military Academy at the end of May, 1943, and his place was taken by another Punjab student in June, 1943. One of the Kashmir students died of enteric in the

Coronation Hospital in August 1944, despite the best medical attention. This class has been singularly unfortunate in losing two of its number during the course. The final composition of the class is as follows: Bengal 1, Central Provinces 4, Madras 7, North-West Fontier Province 1, Punjab 5, Sind 1, United Provinces 2, Bastar 1, Chamba 2, Gwalior 1, Kashmir 4, Kolhapur 1, Mayurbhanj 1, Udaipur 2, and Nepal 1.

Of the course itself I have nothing new to say; the tour and lecture programmes have become more or less standardised. Thanks to the kindness of the railway authorities we have been able to adhere to our normal programme of tours in several provinces. Once again it is my pleasant duty to thank the divisional forest officers in whose divisions the classes have toured for much help and kindness. We are greatly indebted to the Commandant, The Superintendent of Instruction and Staff of the K. G. O. Bengal Sappers and Miners, Roorkee, for continuing to give the classes their valuable course in field works in spite of the pressure on their time caused by the war. We are thankful to the Motor Transport Officers of the 3rd Gurkha Rifles for helping us out with motor transport whenever required. Our debt to the research staff of the Forest Research Institute is, as always, very great; several of them conducted courses in their special subjects and all of them have helped in showing the students round their laboratories and workshops.

This brief (and I fear incomplete) list of officers who have helped more or less directly in the training of the students will serve to show how varied the course is and what a big co-operative effort is needed to ensure proper technical training for forest officers.

Mr. Simmons has referred to the impending changes of staff in the college. I am myself due to leave the college very soon and I should like to take this opportunity to acknowledge my deep debt of gratitude to the staff for their generous help and co-operation; in particular to Mr. Madan who was here before I came and will, I am glad to say, continue here after I have left and will thus help to secure that principle of continuity to which I referred on a former occasion.

This outgoing class has no particular claim to distinction in the field of games and sports and indeed in this respect there has been a decline in their record for the second year as compared with that of the first year. This is no doubt partly due to the fact that many of the students went down with malaria during their C. P. tour in January-February this year.

I have already referred to the unfortunate casualties, the class suffered during the course. The student from Nepal has been in hospital for many weeks and although his condition is improving he is not yet well enough to be discharged. He has consequently been unable to appear in the final examination. With the exception of these cases the health of the students has on the whole been good.

As usual, the final examinations have been conducted by external examiners. Our thanks are due to the following officers for setting papers in the subjects shown again each:

(1) Mr. C. E. Hewetson (Central Provinces) General Silviculture.

(2) Khan Bahadur M. Z. Huq (United Provinces) Silviculture System and Elementary Management.

(3) Mr. N. N. Sen (United Provinces), Genearl Forest Management.

(4) Mr. J. C. M. Gardner and Mr. Hamid Khan (both of the F. R. I.) Forest Entomology.

(5) Mr. R. N. Brahmwar (United Provinces), Forest Engineering.

(6) Mr. E. L. P. Foster (F. R. I.), Forest Utilization.

(7) Mr. M. B. Raizada (F. R. I.), Forest Botany.

(8) Mr. J. L. Harrison (F. R. I.), Surveying and Drawing.

(9) Mr. J. L. Harrison (F. R. I.), Forest Law.

(10) Mr. Z. D. Ahmed (I. G's. Staff), Office Procedure and Accounts.

(11) Mr. Jagdamba Prasad (F. R. I.), Mathematics (held in 1944).

(12) Mr. Hamid Khan (F. R. I.), Soils (held in 1944).

The results are based on the accumulated marks obtained by the students during the entire course and I present them in two statements. The first statement shows the students who have obtained the Honours, Higher Standard and Lower Standard certificates and arranges the names in descending order of

merit (p. 393). The second statement shows the various prize-winners (p. 394).

The results show an unusually wide range of merit in the class. Out of 34 students, three have earned Honours certificates and 25 have obtained Higher Standard certificates. I regret to say that as many as 6 students have had to be awarded Lower Standard certificates. In one case the certificate is being granted "aegrotat."

After distributing certificates and prizes, Mr. A. P. F. Hamilton made the following speech :

"Mr. Simmons, Mr. Ranganathan, Ladies and Gentlemen,

I feel it a great honour to be asked to preside at this convocation and I should like to take this opportunity to thank Mr. Simmons for his kindness in asking me. I think I am right in saying that it is the usual practice to invite as president someone outside the forest department, but in these days every one is very busy and I believe that the Hon'ble Member, Sir Jogendra Singh, was invited but owing to the assembly session, was unable to accept, I am sure, very reluctantly.

As you are probably aware, I have only just taken over charge from Sir Herbert Howard. He has always realised the great importance of sound forest education and it is largely due to his farsightedness that the plans for educating forest officers for post-war development (to which I shall refer later) have got under way so quickly. Sir Herbert is still in this country and though he cannot be here in person, I know that his thoughts are with us.

Mr. Ranganathan, in the course of his speech, has remarked that I was once on the staff of the Ranger College. That is so ; and it is a period of my service which I shall never forget as it was one of the happiest and, I hope, one of the most useful. There is no doubt about it that one feels real pride in one's work, and very justifiably too, as one sees each batch of successful students set out on their life's work. And then, later, it is a real pleasure to meet one's students again, to see how they have progressed in the service and to offer them further encouragement.

The present course has come to a successful conclusion, as Mr. Ranganathan has shown in his speech, and it marks a turning point in the history of the Ranger College. Mr. Simmons has referred to the expansion of the college the temporary arrangements for which are, I understand, almost complete. The expansion plans contemplate four classes in session ; there are already two, the third is about to arrive and the fourth will begin in April 1946 ; from then onwards the annual output of trained forest rangers will be about 75. It is doubtful, however, if even this number will be sufficient to meet the great demand for trained forest officers which must be ready before the post-war plans of the provinces and states can be carried out. I have just mentioned the Indian states, and it is very satisfying to know that their interest in forest conservation is rapidly increasing and an expression of this is the high percentage of seats in the Ranger College, up to 40 per cent., which they are expected to ask for, at any rate during the expansion period. We shall have to accommodate them to the best of our ability, for the full development of India's forest resources and the realisation of the benefits of proper forest management, both direct and indirect, to which the country as a whole is entitled are not possible unless the states march with the provinces.

But I cannot pass on without referring to the difficulties and anxieties which those who had the task of making this expansion possible have had to undergo. There was very little time left over, after the scheme had finally been sanctioned by the Government of India, to make all the necessary arrangements. There were the unavoidable difficulties over priorities for building materials etc., and at the best these are hardly the times when arrangements can be expected to go according to plan. A great burden of extra work has been thrown on the administration and it is a matter for congratulation that the new classes, as the Indian Forest College is also expanding by one class, will be able to open in April.

The new classes will, I fear, start with this unavoidable handicap that many of the staff will be new. But if the new instructors and assistant instructors are determined to work together and to give of their best, and I feel sure that they will, the college will not only give us the large number of rangers which we now require, but it will also maintain the high standard of training which is its reputation. Difficulties there are bound to be at the beginning, such as for example, accommodation, but with good-will all round they can be over-

come. And let it be remembered, when these difficulties arise, that never in the history of Indian forestry has the importance of training been greater than it is now, and that the only thing is to get on with the job.

Mr. Simmons spoke about one important role of the forest officer that of persuading villagers and private forest owners to take interest in the preservation of trees and forests, and I hope you will excuse me if I refer to it again as I have had considerable experience in this side of forest work. It is essential to make the villagers understand that the destruction of the forest on which their livelihood depends means eventually their own destruction, or at least a lowering of their standard of living. And it is true that no one is in a better position than the range officer to win over the villagers and obtain their co-operation; so, what I am now going to say is addressed particularly to those students who have successfully passed their examinations and are about to take up their appointments.

It is unfortunate that the forest officer as guardian of state-owned forests often has to appear rather in the role of a policeman, because these forests frequently provide important necessaries of life for the surrounding villages, and the rules made for the protection of the forest are as much in the interests of the villagers themselves as they are of the state. The chief difference between offences against society and those against the forest is that in the latter case the offender in the long run harms himself and his offspring.

I have never seen police officers collecting villagers and lecturing them on the evils of crime and I do not know what the results would be if they did, but I have seen numerous cases where forest rangers have, through sheer persuasion and personality, converted whole villages, to say nothing of individuals, from the errors of their ways, and have got them to take a real interest in forest protection, improvement of grazing, and the like. To succeed means showing something of the missionary spirit, it means collecting the villagers under the *pipal* tree and sitting with them while you talk; it means inviting free discussion on forest and local economic problems and not merely delivering a pulpit lecture; above all it means showing the villagers that you have come amongst them as a friend and adviser and not only as a forest officer. The villager is indeed conservative and suspicious of suggested change; only tactful and repeated persuasion will succeed in bringing him round to new ideas. But once he is convinced he will not go back. So I say, never give up hope, success often comes when it is least expected; and a forest saved from destruction is worth many new plantations.

While on this subject, there is one more point I would like to make. The necessity for a close alliance between agriculture and forestry in a properly ordered village economy has been urged. This can only be achieved if those concerned understand both sides of the problem, and I advise you all to study the village agricultural and economic conditions so far as they have any bearing on local forest problems, and they generally do. Indeed, this will add considerable interest to your work besides making you far more valuable officers. Of course, it is reasonable to expect the officers of other departments to understand our problems too, but this they will surely do if you show that you are interested in theirs.

Now a word about post-war afforestation plans; some of the provinces, and I hope some of the states also, are proposing to plant or sow up large areas of semi-desert land. Some of you will, sooner or later, find yourselves posted to these duties. You will find this work hard and the discomforts and lack of amenities may be great, but you will take heart in the thought that you are doing real pioneer work. The raising of plantations in these arid tracts will fully tax your skill in silviculture, but you will succeed in the end, I am sure, and you will earn the gratitude of those who will benefit from your endeavours.

Before closing I feel I must say a word about the type of training which we try to give to forest rangers, apart from purely technical training. The first essential is that they should be practical forest officers and this cannot be over-emphasised, then the training imparts the characters of self-reliance and versatility. And the value of this training has been proved by the great diversity of war jobs which forest rangers have had to do, often entirely on their own and away from the support of their department. They have done these jobs well and have upheld the traditions of the service as should have been expected of them. When the war is over the full tale will, I hope be told.

I will not keep you any longer, but I would like to extend my good wishes to those of the staff who are now leaving; their loss will be great and they will be sorry to go, but they will be able to look back upon their work with the knowledge that it has been well done."

INDIAN FOREST RANGER COLLEGE, DEHRA DUN

EXAMINATION RESULTS—1943-45 COURSE

Serial Number in order of merit.	Total Marks obtained out of 4,700.	Name of Student.	Province or State.	Certificate.
1	3,775	Ram Parkash ..	Punjab ..	Honours.
2	3,564	K. K. Nair ..	Madras ..	Honours.
3	3,563	Abdur Rahman ..	Punjab ..	Honours.
4	3,369	K. L. Malik ..	Punjab ..	Higher Standard.
5	3,343	C. H. Prabalanathan ..	Madras ..	do.
6	3,305	M. Kaul ..	Kashmir ..	do.
7	3,288	A. G. K. Menon ..	Madras ..	do.
8	3,269	V. G. Kekre ..	C. P. ..	do.
9	3,265	A. A. Ansari ..	U. P. ..	do.
10	3,240	A. L. Shankhla ..	Udaipur ..	do.
11	3,210	A. Saldanha ..	Madras ..	do.
12	3,187	G. D. Dubey ..	Bastar ..	do.
13	3,187	Arman Ali Bhuyan ..	Bengal ..	do.
14	3,139	T. S. Saini ..	Punjab ..	do.
15	3,101	Abdur Rahim ..	Kashmir ..	do.
16	3,095	S. K. Mohanty ..	Mayurbhanj ..	do.
17	3,082	S. A. Reddi ..	Madras ..	do.
18	3,028	J. N. Kaul ..	Kashmir ..	do.
19	3,014	C. N. Sundram ..	Madras ..	do.
20	2,993	Nagar Mal ..	Chamba ..	do.
21	2,981	M. M. Shafiq ..	N. W. F. P. ..	do.
22	2,958	S. L. Srivastava ..	C. P. ..	do.
23	2,932	Bahadur Singh ..	Chamba ..	do.
24	2,882	Sher Mohammad ..	Punjab ..	do.
25	2,878	M. V. Khisty ..	C. P. ..	do.
26	2,872	T. S. Borgaonkar ..	Kolhapur ..	do.
27	2,864	Akbar Ali ..	Udaipur ..	do.
28	2,820	A. J. Madan ..	C. P. ..	do.
29	2,762	A. D. Choudhry ..	Kashmir ..	Lower Standard.
30	2,726	Ghulam Qadir ..	Sind ..	do.
31	2,717	Azhar-ud-din ..	U. P. ..	do.
32	2,658	B. S. Taley ..	Gwalior ..	do.
33	2,650	A. G. Krishnan ..	Madras ..	do.
34	..	N. B. Basnyat ..	Nepal ..	do.

C. R. RANGANATHAN,

DEHRA DUN:

DIRECTOR,

The 7th March, 1945.

Indian Forest Ranger College.

INDIAN FOREST RANGER COLLEGE, DEHRA DUN

EXAMINATION RESULTS—PRIZE WINNERS—1943-45 COURSE

Serial No.	Name of Prize.	Name of Prize Winners.	Province.
1	HONOURS GOLD MEDAL .. .. .. (To the student gaining most marks in all subjects throughout the course).	Ram Parkash ..	Punjab.
2	SILVER MEDAL FOR BOTANY	C. H. Prabalanathan ..	Madras.
3	SILVER MEDAL FOR FOREST ENGINEERING ..	V. G. Kekre ..	C. P.
4	SILVER MEDAL FOR FORESTRY	Ram Parkash ..	Punjab.
5	FERNANDEZ GOLD MEDAL FOR FOREST UTILISATION	C. H. Prabalanathan ..	Madras.
6	McDONNEL SILVER MEDAL .. .. .. (To the best student from the Punjab or Kashmir).	Ram Parkash ..	Punjab.
7	WILLIAM PROTHERO THOMAS PRIZE .. .. (To the best practical Forester).	Ram Parkash ..	Punjab.
8	" INDIAN FORESTER " PRIZE .. .. (To the best student who has received no other prize)	Abdur Rahman ..	Punjab.
9	DIRECTOR'S PRIZE .. .. .. (To the second best student who has received no other prize).	K. L. Malik ..	Punjab.
10	MARATHON CUPS :		
	(1) Inspector-General of Forests' Cup	N. R. Chaudhry (1944-46 Course). ..	Bombay.
	(2) Second Prize	Nagar Mall ..	Chamba.
	(3) Third Prize	Sher Mohammad ..	Punjab.
11	HAZARIKA MEMORIAL PRIZE : .. .. (To the student gaining highest marks in tour examinations)	K. K. Nair ..	Madras.
12	MADAN'S TENNIS CUP :		
	Winner	T. S. Saini ..	Punjab.
	Runner-up	A. J. Madan ..	C. P.

C. R. RANGANATHAN,
DIRECTOR,
Indian Forest Ranger College.

DEHRA DUN :

The 31*st March*, 1945.

AN IMPROVED METHOD OF PREPARING LEAF COMPOST*

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(*Director of Agriculture, United Provinces, Lucknow*)
and
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(*Research Assistant Soil Chemist, Government Fruit Research Station, Chaubattia*)

A modification of the well known Indore method of preparing compost of agriultural waste material was introduced in 1934 by the senior author. While the Indore method gives satisfactory results on large farms, it has not been adopted for general use by small farmers. If during the monsoon the pits become soaked with water, the final compost is invariably of inferior quality. The Indore method was modified with a view to make it applicable to small holders' conditions. Compost pits under the Indore method were about one and a half feet deep and were provided with drains in the monsoon to take off excess water. As starters, cattle dung, urine and urine earth were used. This method is now being followed by many cultivators in the United Provinces and particularly by nurserymen.

The above method was studied in detail at the Government Fruit Research Station, Chaubattia, Kumaon Hills with dry oak leaves as the basic material. As a result of these investigations, a new method was evolved for use under cultivator's conditions in the Kumaon Hills.

Materials and method

Basic Material: Both oak leaves and pine needles were used in these experiments. These leaves are available in large quantities during the spring months of April and May. While it was easy to prepare compost of oak leaves with all kinds of starters and the cost of composting was comparatively low, with pine needles the results were not quite satisfactory because the cost of composting was high.

Starters: As starters, dung, urine and urine earth in practice were found to be the best. Where cattle are not kept, as in many fruit orchards in the Kumaon Hills, sulphate of ammonia may also be used. Results obtained with this starter were equally good. The best effects were obtained from the treatment in which the cattle dung used was 10 per cent. and the sulphate of ammonia 0.3 per cent. of the bulk of the basic material.

Time of composting: Dry oak leaves are available in the hills during the spring months of April and May and in the plains during the months of March and April, dry leaves of a number of trees can be collected and utilized in making compost. Fairly large quatities of water are required to keep the material in pits constantly moist. Where facilities for watering the pits are not available, the material should be left in large heaps and pits should be filled in only during the rains.

Size of pit: A pit 6 ft. long, 4 ft. broad and $3\frac{1}{2}$ ft. deep is first prepared. The floor of the pit is then dressed to slope gently towards one end, so that at one end the depth of the pit is $3\frac{1}{2}$ ft. and at the other 4 ft. Three small channels 4 in. in width and 4 in. in depth, are then made along the length of the pit, two of them starting from the corners and the third from the middle of the shallower end and leading towards an air hole 4 in. in diameter, in the centre of the base of the deeper end. The air hole provides a common air inlet and is made by boring a hole 4 in. in diameter in the wall of the pit. It is suggested that the manure pits be prepared on the embankments of village tanks where the necessary slope to make an inlet for air is available naturally. Failing this, a small trench, adjoining the manure pit, $5\frac{1}{2}$ ft. deep, should be dug to facilitate the making of an air hole. The channels are covered loosely with pieces of broken pottery or brick over which the material is packed. The channels and the inlet provide free communication for the air and also serve to drain away any surplus water from the compost pit. A piece of clay pipe or thick hollow bamboo may be fitted in the inlet to keep the earth above from falling and choking the passage. The rise in temperature due to

*An interesting article on the method of green composting appeared in the *Indian Forester* in February 1945. —*Ed.*

the decomposition of the organic material causes the warm air in the compost to rise and fresh air to be drawn through the inlet. The provision of air channels in the compost pit is an essential feature of the new method.

Charging the pit: A six-inch layer of organic refuse *e.g.* leaves, trash etc. is spread uniformly on the floor of the pit and thoroughly wetted with a thin slurry of cattle dung (one seer cattle dung in two gallons of water), followed by urine earth (one seer), ash (one handful) and a small quantity of old manure (one seer) to act as activator. Over this, another layer of refuse is put and slurry, urine earth etc. are added. The process is repeated till the material rises to a height of about 1 ft. above the ground level. The pit is then left untouched for 14 days.

Turning: The contents of the pit are turned over once after the first 14 days and every fortnight thereafter during the first two months and once a month subsequently. When turning, the entire material is shovelled out of the pit and put on one side. It is put back immediately, placing the upper portion at the bottom of the pit and bringing the lower portion to the top. At the subsequent turnings the procedure is repeated. In this way the upper and the lower layers are alternately exposed to the atmosphere. Care should be taken to sprinkle water on the material at each turning and oftener if necessary so as to keep the composting material fairly wet. At each turning the small channels and the air inlet should be repaired if necessary.

The compost is usually ready for application to the field in three to four months in the plains.

Procedure to be followed in the hills

Compost pits of the above specifications, because of the sloping ground, can easily be prepared in the hills. The channels on the floor of the pit should be covered loosely by flat stones and the air inlet should open out into the lower terrace. Turning over the material particularly in localities with elevations of over 4,000 ft. above sea level, should be done once a month. The compost is usually ready for application to the field in eight months time.

Quality: The nitrogen content of compost made of oak leaves by the above method was over 2.0 per cent. as against 1.0 to 1.5 per cent. by other well known methods.

In some cases on the plains the nitrogen content of compost made with mixed leaves has been found to be as high as 3.4 per cent. Nitrogen fixation in the compost is remarkable as, in the final product, one invariably finds 40—100 per cent. more nitrogen than was originally present in the basic material and starters. To determine the casual factors involved in this exceptional increase of nitrogen in the compost a series of investigations are in progress at various places in the hills and in the plains.

Economics of the method

It is possible to prepare compost by this method at a relatively low cost as will be evident from the average of three years figures of expenditure given below:

	Hills	Plains
(*i*) Labour for collecting 5 md. of dry oak leaves	As. 10	As. 8
(*ii*) Cost of dung, urine earth and wood ash (2 md. in all) and labour charges for filling one pit 6 ft. × 4 ft.	8	4
(*iii*) Cost of turnings and waterings (water used 200 gallons per pit)	Re. 1	12
Total	Rs. 2-2	Rs. 1-8
(*iv*) Yield of manure containing about 40 per cent. moisture ..	9 md.	
(*v*) Approximate cost per md. of compost ..	as. 4	as. 2-8

The figures given above were obtained in experimental trials where all the material was carefully weighed. Considerable economy can however be effected in the cost of manufacture under conditions prevailing with the cultivator who does not normally employ hired labour. The cost of preparation reported by growers varies from 1 to 1½ as. per md.

Conclusion

A new method for preparing compost manure in pits with dry leaves has been evolved for the particular use of cultivators and orchardists of the Kumaon Hills. The decomposition of organic matter by this method takes place under aerobic conditions. A hole from outside leading to the bottom of the pit, so designed as to drain away surplus water from and admit fresh air to the pit, provides conditions for aerobic decomposition of organic material.

Acknowledgement

The investigations leading to the results detailed above were carried out at the Government Fruit Research Station, Chaubattia, and were jointly financed by the Government of the United Provinces and the Imperial Council of Agricultural Research. The finanacial help of the Council is gratefully acknowledged.

—*Indian Farming*, Vol VI, No. 5, dated May 1945.

PUT POPULATION INTO THE WOODLANDS TO MAKE FORESTRY A SOCIAL CONCERN.*

BY A. J. AUDEN

(Forester, Abitibi Power and Paper Co.)

Why do we want forest management of any kind? Is it not in final analysis, for the primary purpose of building Canada into a great and prosperous nation? A prosperous nation, if you like, so that we as individuals may prosper and may raise happy thriving families, but nevertheless forest management is definitely not an end. It is only one required means to a great and worthy end—public welfare.

For two generations or more, here in Canada, foresters have preached and pleaded for sound management of forest lands, but as yet we have barely made ourselves heard beyond the first row or two of our audience of business men and general public. Why? I suppose at least twenty plausible reasons (I almost said excuses) might be put forward—business cycles, abundant resources, lack of markets, economic conditions—always economic conditions.

If we had laid more stress upon social benefits, instead of straining at the gnat of economic benefits, we might have held the interest of our audience and carried them with us in enthusiastic action. As social values are created, economic benefits for all concerned follow as a matter of course.

More specially, in this case, if we set as our ultimate goal *the establishment of a resident population in the forest,* we will do far more for the cause of forestry, and do it more quickly, than if we set forest management as our goal, and bring in people just to practise forest management.

Only a generation or so back, over 50 per cent. of Canada's population lived in the country. Soon this will be twenty per cent., and we are told that no more than ten per cent., if properly equipped, trained and located, are needed to produce all the agricultural products we are likely to need or be able to sell abroad.

No nation can retain its vigour, or even its social sanity for long if 80 or 90 per cent. of its total population, for two or three generations of crowded city life, is grouped into huge mobs of restless, shifting, functionless mortals, sucked in and spewed out of the great urban factories—backwards and forwards in a sort of rhythmic tribal "Dance of the Business Cycles."

Here is the foresters' opportunity; here is our bounden duty. Let us strive, as never before, to bring about the means whereby a great multitude of these people can get established, with roots in the soil, with a sense of function, a sense of true values, a sense of responsibility to themselves and their country, an understanding of the brotherhood of man.

The universal law—interdependence—will be our ally, if we let it. The nation needs more rural population—a new non-agricultural type of rural population. This new rural population needs forest industries, which can only be maintained by properly managed forests—managed forests require foresters, who if they can see the writing on the wall, will see to it that the building up of a large rural population, supported by the products of forest land is their first concern, and is the foundation of the structure, the roof of which is the sound management of forest lands. I suggest then, that we should be very much more concerned about what we are *not* doing with our forest *land*, than about what we *are* doing to our forests. Or, to put it differently, we have much more cause for reproaching ourselves for what we *are* doing to our forest workers, and to the social structure of the nation, than for our failure to carry out forest management plans.

There may be two opinions about this. Perhaps the best case that can be made for our current practices is that the trend in agriculture is apparently, and perhaps only temporarily, away from the small holding towards the vast, highly mechanized collective farm of Russian type. Similarly, it might be argued, our logging operations should become even more wholesale—mechanized into one vast conveyor belt and assembly line,

*A portion of Mr. Auden's address to the Canadian Society of Forest Engineers, at Fort William, January 30th, 1945.

with forest workers commuting to their jobs daily by aeroplane.

I am not one of those who hold this view. I think that there are certain natural laws, natural forces that will always be stronger than man, and that man must so conduct his affairs that these natural forces work with him and not against him.

The life of a tree far exceeds the productive years of man's allotted span. Two or three generations must live and die while a forest is brought to full fruition. Shall our forest families then be ever on the move, carting home and household ten to twenty miles every ten years or so, an endless circuit extending through the years, from the birth of the grandfather to the death of the grandson ?

We have spent those past 250 years or so on this continent in restless movement, recklessly skimming off the cream of superabundant resources, but we have *not* used the land in the true sense of the word, nor have we done ourselves much permanent good. It is high time we enlarged the family and settled down, not for a hundred years, but for a thousand, for ever, and there's no better country in the world in which to do so. Moreover, if we can't or won't do just that, our nearby neighbours on the other side of this small world may some day think we need their unsolicited assistance.

In my view, therefore, everything points to thousands, perhaps millions, of small forest holdings, individually and intensively managed, passing from father to son, from son to grandson and so on.

I have tried to cover the "why" of forest settlement, and incidentally to suggest that foresters may be well advised to set aside, as of secondary importance, their detailed plans, if any, for silvicultural treatment of forest stands, and to concentrate instead almost exclusively upon helping to solve one of the nation's biggest sociological problems by devising ways and means for establishing on a permanent basis an almost unlimited (for the time being) resident forest population.

There is, of course, another outstanding case to be made for resident forest population, namely that forest operations, whether they be the crudest type of wholesale logging or the most intensive type of managed woodlot, need people to do the work. Since trees are not a city product, forest settlement is the only permanent solution. If proper forest settlement is effected, good forestry practice will inevitably follow as a matter of self-interest.

—*Forest and Outdoors*, March 1945.

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MINOR FORESTS, VILLAGE FORESTS AND FIREWOOD

(EXTRACT FROM A NOTE ON A TOUR IN BOMBAY PROVINCE)

BY A. P. F. HAMILTON, O.B.E., M.C., I.F.S.

(*Inspector-General of Forests to the Government of India*)

Almost everywhere I have heard uncertainty expressed as to how Sir Herbert Howard in his note on Post-war Forest Policy intended that the problem of providing the village consumers with firewood and small timber should be solved. References in this note are made to minor forests but it has been left to provinces and states to work out their own policy and its application. Some forest officers in Bombay were under the impression that the Punjab had solved the problem with their system of village forests managed by co-operative societies. I do not think the Punjab have ever made this claim; but the matter is such an important one and there is so much uncertainty as to what policy to adopt or how to set about creating village forests that I feel that I must try and clear the air.

Minor forests may be owned by individuals, by village communities or by government; they may be managed by the owners themselves or by societies and *panchayats* or by government, or government may manage them on behalf of the owner(s) under some agreement. Thus, village or community-owned forests are minor forests (there may be rare exceptions) but minor forests are not necessarily village forests. It is most unlikely that any one type of minor forest by itself would be capable of solving the problem of supplying firewood and small timber for cultivators and local purchasers in any particular rural area; advantage must be taken of the possibilities offered by local land, economic and social conditions. The main problem is to make firewood available for millions of small cultivators who cannot afford to pay for it; it will be of value to compare the capabilities of the different types of minor forest to achieve this object.

Can forests grown on the village waste and managed by village societies fill the bill? Only to a small extent, I think. The Punjab societies were formed mainly with the objects of organising the village community to protect the common land against erosion, of developing waste land and of increasing prosperity generally. In all cases it has been one of the primary objects of the society to obtain the highest income from the land; thus, although byelaws have permitted the casual removal of dead trees for firewood etc., the bulk of the produce is sold to contractors who probably export most of it.

The same is the case with privately-owned minor forests; the owner keeps what he requires for himself and sells the rest to the best advantage; the money-making urge is too strong.

The ideal which, perhaps, some Utopians look for, is the village forest managed by a society or committee, which daily distributes firewood to the village community, to each according to his needs; the time is, I am afraid, *far distant when this can be considered practical* politics.

A private forests bill may give powers to compel the afforestation and management of waste land by the owner with or without the assistance of government.

Then there is the alternative where government might acquire, either permanently or temporarily on lease, privately-owned land, such as waste, water-logged or saline land, or any land beyond the capacity of the owner to develop for the purpose of raising minor forests. It might be possible so to locate these forests as to make each of them serve a number of villages conveniently and sufficiently closely grouped round them. It would be a matter of policy whether government would insist on these forests being made to pay for themselves or whether the produce should be sold at nominal rates which would involve a loss in their management. In the former case it would be practicable to establish this type of minor forest only in localities where the cultivators are sufficiently prosperous to pay a fair rate for

their fuel. But a broad view must be taken; large tracts of country are under-developed and can only be developed through government agency. The afforestation of waste land may help to give effect to other objects of long-term government policy, *e.g.* the increase of the percentage of land under forest on general climatic and economic grounds, to reduce water-logging or prevent erosion, to mitigate the effect of hot, dry winds and to reclaim and improve intractable land generally, in such cases, firewood production would be a secondary object and a policy of free grants would be justified.

My feelings, however, are that the mass of poor cultivators must have their firewood free, must be able to get it as they want it, *i.e.* during the day's work, and it must be within easy reach; they will never use it unless it comes to them free and easy as it does in the case of cow-dung. Where large forest grazing grounds exist, those who tend the cattle usually return in the evening with a head-load of dry firewood and no serious problem arises here; but far and wide I think the ultimate solution lies in the cultivator growing his own firewood on the borders of his fields, on the little patches of waste ground round wells and habitations, along the banks of streams and torrents etc. Here and there this is already done; it requires encouraging, directing and assisting by the free supply of plants and seed. And I would go so far as to say that in barren tracts like the Deccan, and the Thal of the western Punjab, where trees are also required as wind-breaks, these measures must be accompanied by the compulsory exclusion of goats, as is, in fact, being done in the Deccan.

But I do not believe that minor forests in themselves are sufficient; they must be integrated in a wide policy of firewood and charcoal production which may even include provision for export. Large towns, small towns, industries, and countless consumers in the country, other than the cultivators, require firewood or charcoal and are able to pay for it; there is therefore plenty of room for the firewood sold by the village forest society or the private owner and they should not be discouraged merely because they do not cater for the small cultivator; for the cultivator will be tempted by high prices to sell to the purchasing consumer instead of using his firewood himself, unless the latter can obtain it cheaply elsewhere. This happened during the war in many parts of India and has resulted in a serious depletion of tree growth in the countryside. Thus it is clear that the success of any scheme designed to encourage the use of firewood instead of cow-dung may depend to a greater or less extent on the adequacy of an administration's plans to provide cheap fuel for all classes of consumers, and this is particularly important in localities where communications are good.

Minor forests, therefore, may be anything from government-owned and managed forests down to a small patch of trees growing round a cultivator's well or a row of trees on a contour bund or minor irrigation channels; they would also include roadside and canal avenues. Local conditions, which may vary even within one district, must decide the best means of tackling the problem. Obviously one important factor is the availability of suitable land and it may well be that in some provinces before a satisfactory firewood plan can be drawn up, as indeed they must, a utilisation survey of waste and uncultivable land will have to be made.

ORGANIZATION AND LEGAL POSITION OF THE LAND IMPROVEMENT SECTION, PROVINCE OF BOMBAY.

BY V. A. N. SAUSMAN, ESQUIRE, M.B.E.

(*Land Improvement Officer, South Circle, Bijapur*)

The History

The repeated failure, partial or total, of the crops in the Deccan called for urgent and earnest efforts to alleviate the economic conditions prevailing in that tract and the Bombay Government decided to make a determined effort to do so under the Post-war Reconstruction Programme.

The decision to postpone the effort till after the war was forced on government by the labour and other problems arising from the abnormal war conditions. After the war, labour, in the form of troops awaiting demobilisation, was expected to be adequate for the work and it was deemed advisable to keep the men employed till they could be settled on

the land or settled in permanent civil employment. The placing of the men on the community, after the payment of gratuity, without any provision for civil employment, caused serious discontent amongst the demobilised soldiers after World War I. Not only was this error not to be repeated this time, but the military training itself was to be capitalised to fit the men for future civil employment on the land or in the office or factory.

The Government of Bombay began to prepare, early, for the future work and, in 1941, not only set up a Bunding Section under the Agricultural Department but deputed four officers, of whom I was one, to visit and extensively tour the Punjab Province to study the anti-erosion work being carried out therein. Early in 1942 the Land Improvement Schemes Act was enacted to accord legal sanction to any future work undertaken for soil and moisture conservation considerations.

About this time Sir Cusrow Wadia, a Bombay philanthropist, was so moved by what he saw of the Soil Conservation Services' work in America, and realising the great possibility of the application of those practices to Indian agriculture, that he made a princely donation of seven lakhs of rupees for the establishment of a Trust, the interest from which was to be utilised towards the introduction of soil conservation to Indian farming in the province. The Bombay Government immediately declared its intention to annually contribute a sum equal to the interest on the donation by Sir Cusrow for a similar purpose. From those sums grew the "Sir Cusrow Wadia Trust Fund."

The Government of Bombay established, late in 1942, the post of Deputy Director of Agriculture, Land Development, under whom the work in the Presidency was centralised and plans and estimates for a number of Village Developmental and Block Bunding Projects were drawn up and sanctioned.

The Village Developmental Project was to cater mainly for the bigger landlord and it therefore was confined only to projects which, as units for work, contributed 500 or more acres for bunding. A subsidy of Rs. 5 per acre was paid to the land-owner from the "Sir Cusrow Wadia Trust Fund" mainly as a contribution towards the construction of waste-weirs.

The smaller land-owners were catered for by the Block Bunding Projects under which blocks of from 200 to 500 acres were the units for work and these were also subsidised to the extent of Rs. 5 per acre by the Government of Bombay. Subsidy for block bunding schemes was separate from the contribution made by Government towards the "Sir Cusrow Wadia Trust Fund."

This was the position when the monsoon of 1942 failed and precipitated a famine which was severer, in intensity, than usual because of the partial failure of the monsoons of 1940 and 1941 when scarcity conditions prevailed. The famine provided a very considerable labour supply for any work to be undertaken and the Government of Bombay, accepting the opportunity, constituted in February, 1943, the post of "Land Development Officer, Scarcity Areas" and appointed me to it. It was the intention of Government that I should act as a Liaison Officer between the Revenue and Agricultural Departments and that I should also carry out propaganda to induce villagers to freely take loans from Government in order to construct bunds.

I assumed charge of my post at Bijapur on the 10th of March, 1943, with two clerks sanctioned, but not available. A rapid and close inspection of the factors of the locality at once established that the whole system required revision. It was clear that problems of soil erosion did not commence and end at field boundaries nor even at village boundaries. They were common to whole catchment areas which required treatment as a unit. Further, the rainfall was so scanty, and precipitation so irregular and uncertain that, whilst any given precipitation may have been in surplus at the time, there was never any certainty that it was in excess. To illustrate this point, let me quote the rainfall for the six months, June to November, 1942, inclusive, when a famine occurred. The Monsoon burst with a precipitation of 5″ in June, 1942, and, at the time, the water appeared both in excess and surplus to agricultural requirements. There was however no further precipitation in June, 1942, and for the remaining five months only 5·50 inches, making a total of 10·50 inches (approximately) fell, leading to crop failure and famine. The key then to the problem was to treat any heavy precipitation as a surplus but not as an excess and to impound all the rainfall as and when it fell. This led to the abolition of waste-weirs and the spacing of bunds at somewhat closer intervals over the whole catchment.

I claim authenticity and responsibility for the introduction of (*a*) contour bunding of whole catchment areas and (*b*) for the entire abolition of waste-weirs. The introduction of these innovations was made possible only by the permission and authority of the Bombay Government, who not only permitted the use of the large labour force available—it reached the peak of 40,000 daily labour in August, 1943 —but placed the necessary funds at my disposal for carrying out "Experimental Large Scale Bunding and Dry Farming." Without this generous assistance, I should have been helpless. The able guidance and sympathy, shown to me throughout the work by the Director of Agriculture, Province of Bombay, Poona, Sir William J. Jenkins, B.SC., M.A., I.A.S., C.I.E., KT., were of inestimable value and encouraged me to venture where I should otherwise have hesitated.

The result of these encouragements was that about 1,25,000 acres were improved during 1943-44, free of cost to the owners but at a cost of approximately Rs. 12,00,000 to Government. This expenditure includes the cost of small scale agricultural experiments under the scientific dry farming methods carried out by a nucleus of the Agricultural Section attached to the Land Development Officer. The total strength then was 3 officers and about 20 subordinates.

The data disclosed that (*a*) labour in sufficient quantity, would be available even in a normal year, for large scale works, (*b*) that one competent surveyor could survey 50 acres or 2 running miles of survey per day, (*c*) that this could provide work for from 1,200 to 1,500 labour, daily, (*d*) bund size and drop percentage were determined and (*e*) miscellaneous data. The data so collected were also applied to the Land Improvement Schemes Act and many amendments effected.

On the data so collected the Government of Bombay established two Circles—the North and the South—and in December, 1943 framed its post-war plans.

Present Position

On the data collected the Government of Bombay decided that (*a*) in the 1st year of the Post-war Reconstruction Plan 5,00,000 acres should be improved, (*b*) 6,00,000 in the 2nd year of the plan, (*c*) 8,00,000 in the 3rd year, (*d*) 9,00,000 in the 4th year and (*e*) from the 5th year to the 15th year 10,00,000 acres annually.

The Legal Position

The legal position at present is that defined by the Land Improvement Schemes Act, No. XXVIII of 1942 and subsequent amendments. Its provisions are many, the main are:

(*a*) The constitution of a Board consisting of the Revenue Commissioner as Chairman and the Director of Agriculture and the Conservator of Forests of the area as members. The Land Improvement Officer is *ex-officio* Secretary to the Board. There is a separate Board for each Revenue Division.

(*b*) This Board directs the preparation of the Land Improvement Scheme for any area within its jurisdiction. A scheme may provide for all of the following: soil and moisture conservation, introduction of Dry Farming methods, improved agricultural practices, reclamation of water-logged land or land from the sea, control or prohibition of grazing, control or maintenance of vegetation and tree growth and/or any matter not inconsistent with the objects of the Act.

(*c*) The Board appoints an officer to prepare a Draft Scheme which must state the objects of the scheme, the area proposed to be covered by the scheme, the nature of work to be carried out, the agency through which execution is to be effected and any other particulars as may be prescribed.

(*d*) The officer so appointed, prepares and submits the scheme to the Board which may accept it with or without modifications or even reject it. If the Board accepts the scheme it is published in the official gazette, in the village or villages covered by the scheme, at the *Taluka* or *Mahal* and district headquarters in which the areas lie. An Inquiry Officer is immediately appointed by the Board to hear and record all objections to the scheme or part thereof. These objections may be oral or written

and must be made within 21 days from the date of publication of the scheme in the official gazette. The Inquiry Officer is granted summary powers under the Land Revenue Code of 1879 and has power to summon and enforce the attendance of witnesses who can be examined on oath and who can be compelled to produce any documents essential to the enquiry.

The Inquiry Officer submits his enquiry report, with such modifications he may deem necessary, to the Board which, provided the objections are less than 33 per cent. of the owner or owners owing 33 per cent. of the land, other than the Crown lands, sanctions the scheme with or without modification or rejects it. If the objections exceed the prescribed limit the Board must submit the scheme with or without modification or reject it. If there is acceptance of a scheme either by the Board or Government it must be published in the official gazette, in the village or villages concerned and the *Taluka* or *Mahal* and district headquarters in which the lands lie. Publication of a scheme causes it to become final, legal and in force from the date of publication. The Board also has powers to make regulations in respect of any matters supplementary or incidental to the scheme.

After the scheme has come into force the Board will appoint an officer to execute it and it will specify the period within which the cost of executing the scheme will be recovered from the respective owners. Any person wishing to execute the work in his own lands shall be permitted to do so provided he gives notice in writing, to this effect to the executive officer within 21 days of the publication of the sanctioned scheme in the official gazette and undertakes to complete the work within the period stipulated by the executive officer. Failure to do so entitles the executive officer to carry it out by Government agency at the cost of the owner.

On the completion of a scheme, the executive officer prepares a statement, with a map, detailing the work done with cost thereof, the total amount to be recovered from the owners, the general rate per annum or per rupee of recovery, the period of recovery, the person or class of persons responsible for maintenance of the work in repair and a list of survey numbers or sub-divisions from the owners of which a rate other than the usual rate is to be recovered for specific reasons, to be recorded.

The statement with the map is sent to the *Mamlatdar* or *Mahalkari* for incorporation in the Record of Rights. Every person shown as liable in the Record of Rights must maintain and repair the works carried out to the satisfaction of the Land Improvement Officer. If a person fails to do so within the time prescribed by the Land Improvement Officer, this officer shall repair the work at the cost, plus a surcharge of 25 per cent. of the cost of repair, of the land-owner.

The Provincial Government may themselves direct the preparation of any scheme in any area in which famine or scarcity prevails or is likely to prevail, or in any case in which the Provincial Government or Trust may contribute not less than 25 per cent. of the cost of the scheme, or in any area in which Land Improvement is necessary, in the interest of any member or members of H. M. Forces, whether in service or retired, or of their dependents. The Government appoints an officer to prepare the draft scheme which is submitted to Government through the Board. Thereafter the procedure is the same as that prescribed for schemes ordered by the Board.

All schemes executed to date or in the process of execution have been directed by Government and are carried out by Government agency.

A penalty clause has been added to the Act. It lays down that if any person contravenes any provisions of the sanctioned scheme or any of the regulations made by the Board or fails to fulfil any liability imposed upon him, he shall on conviction be liable to a fine up to Rs. 50 or with simple imprisonment for a period up to one month or both.

The Organization

The sanctioned cost per acre, at present, is Rs. 12 plus Rs. 3 per acre for Dry Farming. A land-owner has to repay Rs. 9 per acre towards the cost of the bunding. For the first two years, after the land is bunded, he repays nothing and thereafter he repays annas twelve (12) per acre per year, for 12 years. There are no interest charges, but the land-owner must, from the second year after the lands are bunded, maintain the bunds in proper repair. Government undertakes to maintain the bunds in proper repair for the first year after the lands are bunded.

IMPROVEMENT

The staff for the Development of 1,00,000 acres was estimated to be:

Survey:

(1) Survey Engineer .. One Gazetted Class II.
(2) Senior Surveyors .. Two non-gazetted.
(3) Asstt. Senior Surveyors .. Four.
(4) Junior Surveyors .. Fourteen.
(5) Clerks .. One (Junior).
(6) Tracers (Field) .. Six.
(7) Tracers (Office) .. Eight.
(8) Overseers .. Thirty-two.
(9) Khalasis .. Twenty-four.

Dry Farming:

(1) Dry Farming Officer One Gazetted Class II.
(2) Asstt. Dry Farming Officers .. Two non-gazetted.
(3) Dry Farming Assistants .. Four.
(4) Dry Farming Managers .. Twenty.

For the full programme of 3 lakh acres to be improved in 1944-45 (the first year of the first five-year post-war planning), the following staff was sanctioned:

(*a*) One Land Improvement Officer .. Class I.
(*b*) One Asstt. Land Improvement Officer .. Class II.
(*c*) Four Survey Engineers Class II (of whom one is Reserve).
(*d*) One Superintendent, Bunding Training Class Class II
(*e*) Three Dry Farming Officers .. "
(*f*) One Sub-Divisional Forest Officer .. "
(*g*) One Land Improvement Superintendent (Land Records) .. "
(*h*) One Special Accounts Officer .. "
(*i*) One Store Superintendent, non-gazetted.

Each one of these officers is supplied with his own staff, according to the functional requirements, and, though independent of each other, co-ordinates his work with that of the others so that the greatest benefits may accrue to the lands.

To arrive at the necessary staff it was urgent to realise that soil conservation embraced in its sphere all erosion-control, water facility, flood control, sub-marginal land development, farm forestry, etc., in order to provide comprehensive land utilisation and conservation.

The Land Improvement Section's broadened field of service includes many different lines of action—each with its own immediate objective—but it is evident too that these different lines of action have a common purpose, the betterment of human welfare, the conservation of natural resources, the establishment of a permanent and balanced agriculture and the reduction of the hazards of floods and siltation.

Experience, observation and commonsense all dictate the wisdom of weaving the various lines of action together into one strong fabric, thus avoiding duplication of effort, assuring community of action and reducing overhead charges.

After all, the problems to be faced are not separate and distinct. In the field it is found that the problems and their probable solutions blend into each other so that it is hard to tell, for example, where erosion-control leaves off and flood control begins or where water conservation ends and the development of water facilities begin.

The nature of the job to be done, the fact that in the field there are a number of work programmes tending to merge into each other and that the same techniques are employed to attain different immediate and long term objective has in a large measure determined the form of the Land Improvement Organization.

A study of the field activities will disclose that the several work programmes—erosion control, water facilities etc.,—have more in common that the different techniques employed within those programmes.

Erosion-control and water facilities, as separate programmes, resemble each other more closely than do, say, the technique of engineering and forestry. Moreover, these same techniques of engineering and forestry are employed in both programmes.

Similarly the sub-marginal land development and erosion-control programmes, resemble each other more closely than do agronomy and wild-life management, but both agronomy and wild-life management are employed in the two work programmes.

With similar programmes of work sharing broad objectives, and a number of widely differing techniques a functional type of organization, rather than a programme type, is called for.

We have therefore divided our organization and administrative units on the basis of functions rather than on the basis of programmes. For example, since the technique of tree planting is the same—whether the tree be planted for erosion-control, flood control, sub-marginal land development or for any other purpose, we let the same man administer the tree planting work for all purposes.

The same is true for agronomy, wild-life management, engineering, farm management, information and education. Thus the different programmes are integrate, tied together in one programme -and duplication is reduced to a minimum. The co-ordination of the inner working of the Land Improvement Section is much simpler in a functional type of organization than it would be in a programme type.

Such an organization is flexible—readily adaptable to the varying needs of different areas, and it is capable of assuming an almost un-limited number of additional duties and responsibilities. A request, say in a time of famine, to take over a vastly expanded programme in any particular technique would compel us, of course, to increase our personnel, but the present form of our organization would remain the same. That form is such as would permit practically the whole of the funds assigned for the expanded programme to be passed into the field and used there in actual field operation.

The fact that expansion of the programme will eventually mean a reduction in the percentage of total overhead costs, is an added great advantage of our form of organization. In this regard the functional type of organization differs greatly from the programme type. If we were to proceed on the programme basis, the relative costs of administration and operations, within each programme, would be definitely fixed, and as additional work to us increases, overhead charges would necessarily advance at the same rate as operation costs.

As it is, absorption of a new programme is likely to result in a revision of that programme's budget, with a view to cutting administration costs to a fraction of their former figure, while increasing the funds available for field work.

The functional organization might be compared to the pyramids, with the upper portion representing administrative overhead and the base representing the spread of actual field observations. At the start the pyramid was slender with the walls slanting only slightly as they reached the base. As the organization grew and additional programmes were undertaken and broken up into functional units, the pyramids base became broader and its walls more concave and sloping.

Instead of a group of pyramids each representing a different programme, and with each assigned a definite apex portion to overhead, we now have one pyramid in which the apex or overhead portion has not expanded, at anywhere near the same rate as the base of the pyramid.

As the Section grows, the relative size of the different parts varies, but the essential form remains unchanged. The tendency is not towards more and more rigidly centralised control of all activities, but rather towards decentralisation of control.

The functional type of organization is carried down through the various levels of authority, from Government, to the Director of Agriculture, to the Land Improvement Officer, to Regional Officers, to the Area Officers and down to the work units in the fields. At the higher levels, only as much authority has been retained as is necessary to assure proper co-ordination of activities, adherence to established policies and general efficiency of performances. Every effort is made to pass as much responsibility as possible on to field units, so that local personnel will have the necessary freedom to deal promptly and effectively with local situation.

Establishment of the District (Regional) Office set up was of special significance in this regard. Not only should this cut out overhead charges by reducing the number of administrative authority in the field. With the passage of time we shall all become increasingly aware of the broad purposes of our work, and of the policies governing it. Then more and more freedom for self-determination is going to be exercised by Field Officers.

The Government functions in the determination of programmes and policies. The Director of Agriculture functions in the distribution, interpretations and applications of programmes and policies, and determines policies based on service policies. The Land Improve-

ment Officers distribute and apply programmes and policies. The Regional Officers execute programmes in accordance with established policies through their field units.

In action the flow of material through the administrative line is by no means one way. In action the administrative lines not only tie the organization together but also operate as sort of circulatory system. Ideas and information gained from practical experience with the job, at the ground, flow up from work units through administrative channels to the upper level of authority. There they are sifted and examined and those found valid flow back down through administrative channels as policies, procedures and approved programmes.

But all villages are not so fortunate. There are some which have not awakened to the dangers of soil erosion whilst others are as yet unattended owing to limitations in staff. They however look with curious eyes at the lands of the co-operating villages with its problems solved. They are aware of diminishing returns in the form of crops and they see the gullies crawling and enlarging through their own slopy lands. Some are trying to copy the work done in the completed villages, but they are finding trouble and need some help in making complete farm conservation plans. They are anxious now to join up. They have numerous battles to fight against floods, poverty which rides down those who operate sub-marginal farms and even against a rising water-table that drowns crops and pastures in low bottom lands. They need, and want, a co-ordinate attack on their various physical enemies, for they realise these destructive forces are closely allied.

These villages are within the areas covered by the Land Improvement Section and are determined to take full advantage of the facilities afforded through the law, but what of the areas of India not so covered ?

There is a daily increase in the number of farmers seeking either help or information to make their soil conservation plans.

There is a moral to this—it is a very important one too.

By the farmers the job is considered from the stand point of land itself as one of use adjustment. It is our job to help these farmers plan for a reasonable living from these resources using the income and conserving the capital. The Land Improvement Section has brought to the people the facts about land abuse and how to correct it. They have shaped an organization through which they can harness and employ for their own use technical energies. They have shown the green light and are still directing the traffic.

The district is the door-way to the future. It is the door-way through which the transition is being made from exploitive, competitive agriculture of the past and present, co-operative, conserving agriculture of the future. It is designed in accordance with Indian traditions and practices democratic in conception. The district stands firmly grounded in the good Indian soil.

REFERENCES:

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GRAZING AND PASTURE RESEARCH IN THE UNITED PROVINCES*

By P. C. Kanjilal, I.F.S.

(Silviculturist, United Provinces)

FOREWORD:

The results of such grazing and pasture research as had been completed in the U.P. up to March, 1939, are to be found *in U.P. Forest Leaflet No. 11, of 1939*, a summary of which is repeated as below:—

"(1) Grass production gradually improves for 3 or 4 years, both with partial and with complete closure to grazing

(2) Thereafter variations in grass yield appear to depend largely on the monsoon rainfall, good rains producing appreciably more than bad rains in both types of areas.

(3) After 3 years' complete or partial protection, the average grass yield for the past 5 years (3 good and 2 bad), shows:—

(a) for grazed areas (protected 5 months annually in monsoon) an increase from 2.75 to 11.1 maunds per acre dry grass = 400 per cent. increase;

(b) for completely protected areas, an increase from 2.75 to 13.7 maunds per acre = 500 per cent. increase (The apparent difference between 11.1 and 13.7 does not allow for the quantity of grass grazed by the cattle from the open areas in 7 months).

The difference between (a) and (b) scarcely justifies complete and continuous closure.

(4) The conclusion is that closure during the rains is adequate, and complete closure unnecessary."

The area at Makhdoompur covered by the above-mentioned experimental determination, was subsequently utilized for further experimental observations, for which a new layout was devised in March, 1939. This experiment, having run its course for 5 years, has now been closed down and the appended note recorded by the silviculturist, U.P., is of of considerable interest, since it not only confirms our previous deductions but it indicates:—

(a) that periodic grazing for eight months combined with monsoon closures is definitely preferable (from the point of view of grass production as well as simplicity in application) to rotational grazing for one month followed by three months' rest, in rotation throughout the year, and

(b) that provided monsoon closures are regularly and effectually enforced, the production of grass is unaffected by the incidence of grazing during the rest of the year.

Further investigations with parallel replications are now proposed, to confirm the above deductions or to determine the limiting incidence of grazing that can be applied to areas regulated under schemes of periodic (monsoon) closure, without causing the pasturage to deteriorate. In the meantime, however, our practical experience gained in attempting to apply various methods (both periodic and rotational) devised for regulation of grazing in a number of blocks of waste land controlled by the forest department in Etawah and other districts, points clearly towards the advantages of employing the simplest and least restrictive methods for all initial schemes of regulation, until such time as the local population becomes sufficiently educated in the advantages to be gained by more complicated and more restrictive arrangements. It appears that the 3rd scheme (periodic grazing on a two years' cycle) advocated by Mr. D. L. Sah, I.F.S., *in U.P. Forest Leaflet No. 10*

*Paper presented at the Sixth Silvicultural Conference, Dehra Dun (1945), through the Conservator of Forests Working Plans Circle, United Provinces, on item 8—Grazing and Pasture Research.

of 1938 entitled "A note on the prevention of the extension of erosion in ravine lands and improvement of fodder and grazing in waste and ravine lands" is the simplest and least restrictive that can be devised. In light of the Makhdoompur observations it is therefore proposed to follow this system for initial regulation in future, subject to any revision of the current standard of limiting incidence, viz., 2 acres per cow, that may be found desirable.

E. W. RAYNOR,
Conservator of Forests,
Working Plans Circle, United Provinces.

GRAZING EXPERIMENT IN AN *USAR* AREA AT MAKHDOOMPUR, DISTRICT UNAO UNITED PROVINCES—SILVICULTURE DIVISION EXPERIMENT No. 6.

This experiment was commenced on 1st March 1939, in continuation of Experiment No. 3, on a site which was formerly an old military camping ground—now abandoned and under private ownership and rented since July 1931, for experimental purposes. The previous experiment had been laid out for the study of improvement and natural succession, if any, of grasses in a typical *usar* area under various methods of treatment and had considerably improved the initial grass crop by 1937, when the experiment was closed after grass cutting and weighments in November 1937. The final report of this experiment was published in 1939 in *U. P. Forest Leaflet No.* 11. The whole area was then closed to grazing till the present experiment was laid out. The object of protecting the area in this way was to enable the small differences in the sub-plots to even up and also to provide by means of weighments of the grass in October an index of initial comparability for the revised experiment. The results of the weighments of November 1938, and also those of November 1937 in each of the approximtely 4-acre plots in which the area had been divided in the former experiment are given below:

Sub-plot under Experiment No. 3	Weight of grass in maunds per acre after ten days driage	
	1937	1938
.11	9.07	13.75
.12	17.48	19.60
.21	9.21	16.47
.22	14.65	17.32
.31	7.81	11.75
.32	11.66	14.37
.41	10.00	13.57
.42	12.00	13.22

The figures indicated that sufficient evening up had taken place to continue the investigations a step further, *viz.*, to determine the results of rotational controlled grazing on part of the area and to compare them with the results of periodic grazing (controlled and also uncontrolled) in the remainder.

PLAN OF LAYOUT AND ORGANIZATION OF THE EXPERIMENT.

The revised layout is shown in the diagram given below. The total area of about 32 acres was divided up as follows:

Sub-plot A=8 acres

„ B=8 „

Paddock a=4 „

„ b=4 „

„ c=4 „

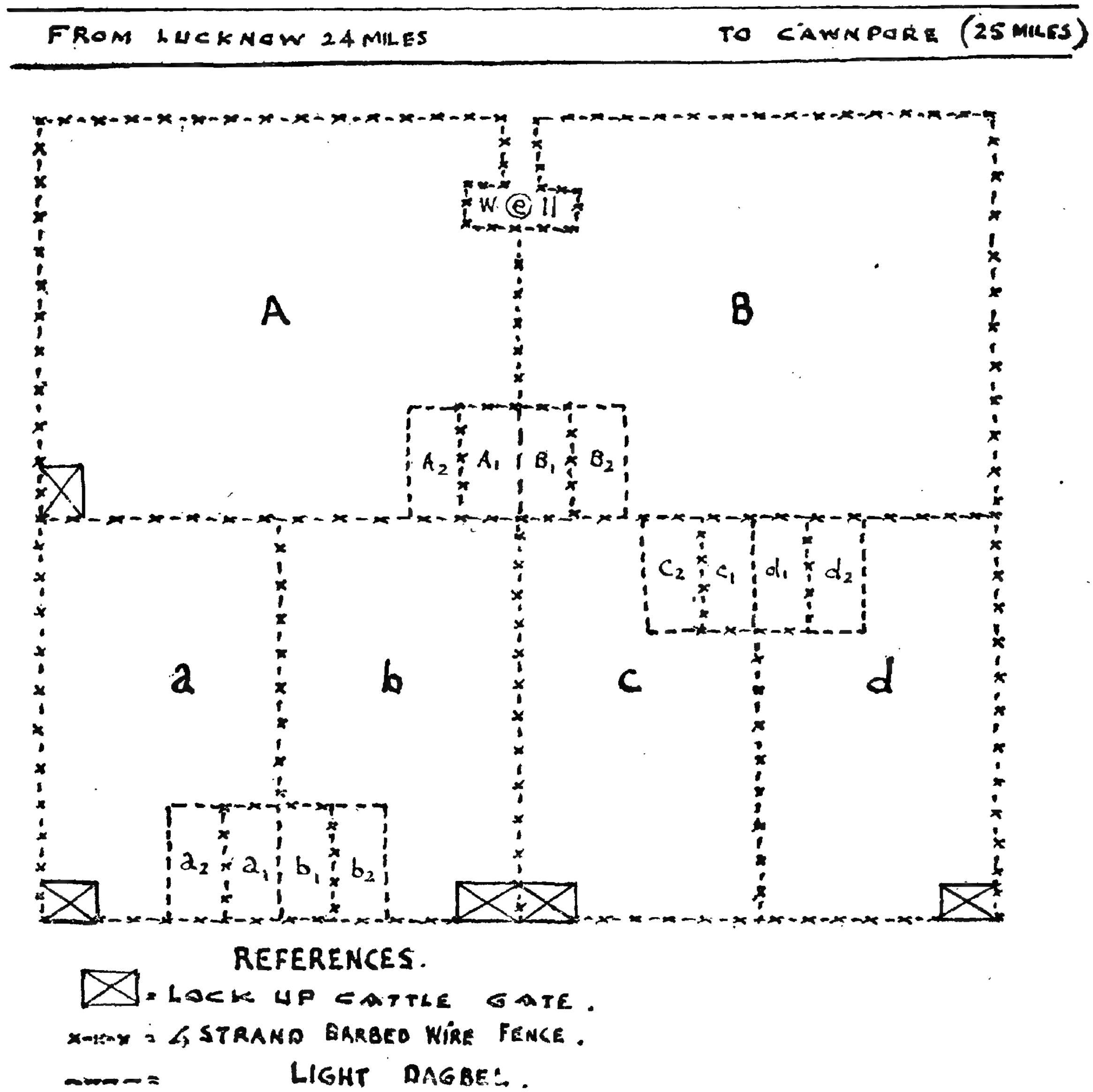
„ d=4 „

A_1, B_1, a_1, b_1, c_1 and d_1—fenced indicator plots each 0.2 acre (2 ch.×1 ch.).

A_2, B_2, a_2, b_2, c_2 and d_2—unfenced indicator plots marked by *dagbels*, each 0.2 acre (2 ch. × 1 ch.).

MAKHDOOMPUR GRAZING EXPERIMENT

DIAGRAM OF LAY OUT



A. Periodic Grazing.

Sub-plot A together with unfenced indicator plot A_2 was opened to the grazing of eight cattle (*i.e.*, one per acre) from 16th October to 15th June each year, and protected from grazing from 16th June to 15th October each year. Fenced indicator plot A_1 was continuously closed to grazing. On the 15th October each year grass was cut and weighed in indicator plots A_1 and A_2, first green and then after ten days' driage. The cut grass in indicator plot A_2 was left *in situ* and that in A_1 was removed for feeding to cattle.

Sub-plot B together with unfenced indicator plot B_2 was opened to the grazing of cattle without limit from 16th October to 15th June each year and were closed to grazing from 16th June to 15th October each year. Fenced plot B_1 was continuously closed to grazing. On the 15th October each year, grass in B_1 and B_2 was cut and weighed, first green and then after 10 days' driage. The cut grass in B_2 was left *in situ* and that in B_1 was removed outside for feeding to cattle. The fence surrounding this sub-plot was dismantled sufficiently to encourage cattle to enter.

B. Rotational Grazing.

Paddocks a, b, c, d together with their respective unfenced indicator plots a_2, b_2, c_2 and d_2 were grazed in rotation each by 16 cattle for one month at a time according to the following schedule:

Bund.	Paddock.	1st year (open in)	2nd year (open in)	3rd year (open in)	4th year (open in)	5th year (open in)	6th year (open in)
		1939	1940	1941	1942	1943	1944
I	*a*	January	December	November	October	September	
	b	February	January	December	November	October	
	c	March	February	January	December	November	
	d	April	March	February	January	December	
II	*a*	May	April	March	February	January	
	b	June	May	April	March	February	January
	c	July	June	May	April	March	February
	d	August	July	June	May	April	March
III	*a*	September	August	July	June	May	April
	b	October	September	August	July	June	May*
	c	November	October	September	August	July	
	d	December	November	October	September	August	

**Grazing closed from June* 1, 1944.

On the 15th October, each year the grass in indicator plots a_1, a_2, b_1, b_2, c_1, c_2, d_1, d_2 was cut and weighed first green and after ten days' driage. The cut grass in the fenced indicator plots and in the unfenced indicator plots in paddocks not open to grazing in October, was removed from the plots for feeding to cattle, while in unfenced indicator plot in the paddock open to grazing it was left *in situ*.

Result.—The following tables show the detailed results of sampling (in maunds per acre) up to October, 1944:

I. PERIODIC GRAZING.

(*Open to grazing from October* 15, *to June* 15).

Sub-plot.	October 1939	October 1940	October 1941	October 1942	October 1943	October 1944	Average for six years.	Incidence.
Monsoon rainfall:	—8%	—17%	—39%	+14%	+5%	in deficit.*		
A	16.25	6.30	5.10	13.95	10.25	11.57	10.57	Open to grazing by eight cattle units (one per acre).
B	21.25	11.50	8.87	16.50	18.87	14.52	15.25	Open to unlimited grazing.

*Exact figures not obtained yet.

II. ROTATIONAL GRAZING (ACCORDING TO SCHEDULE ON PAGE 420)

(*Open to grazing by* 16 *cattle units by rotation for one month thrice a year.*)

Paddock								
a	4.38	1.37	1.87	10.12	3.12	8.95	4.97	Average annual incidence of grazing =1 per acre.
b	13.88	1.12	0.75	5.75	12.25	8.57	7.05	
c	7.00	1.50	0.34	2.00	627	8.85	4.33	
d	8.31	4.87	2.60	4.50	4.0	13.15	6.24	

III. INDICATOR PLOTS ENTIRELY CLOSED TO GRAZING. GRASS CUT IN OCTOBER AND WEIGHED AFTER TEN DAYS' DRIAGE.

Indicator Plot							
A_1	19.87	11.80	9.50	15.45	17.62	20.60	15.80
B_1	18.10	12.00	11.87	15.37	16.50	16.25	15.01
a_1	19.00	13.50	8.87	14.75	18.00	21.07	15.86
b_1	20.60	12.37	8.25	16.20	16.50	22.80	16.12
c_1	16.37	10.00	11.50	15.87	11.37	19.35	11.07
d_1	18.06	16.10	14.10	17.81	19.45	21.80	17.88

An abstract summary of the results is given below:

RESULTS OF SAMPLING, EXPRESSED AS YIELD IN MAUNDS PER ACRE

(Grass dried for ten days before weighments)

Areas.	October.							Remarks.
	1939	1940	1941	1942	1943	1944	Average	
1. 8 acres grazed by 8 cattle units for eight months each year ..	16.25	6.30	5.10	13.95	10.25	11.57	10.57	No monsoon grazing.
2. 8 acres open to grazing by unlimited number of cattle for 8 months each year ..	21.25	11.50	8.87	16.50	18.87	14.52	15.25	"
3. 16 acres open to rotational grazing for one month, thrice a year, by 16 cattle units; (mean yields) ..	5.89	2.21	1.39	5.59	6.41	9.88*	5.23	No grazing after June 1, 1944.
4. Areas completely closed to grazing but grass cut once a year in October; (mean yields) ..	18.66	12.63	10.66	15.91	16.57	20.31	15.79	

General Observations.

The dominant grass in the area is *usar* (*Sporobolus arabicus*). *Phulna* (*Chloris* sp.*) ranks next in degree of abundance and is co-dominant in years of good rainfall. The composition and yield of the crop varies according to rainfall. *Sporobolus arabicus* is more xerophytic and suffers proportionately less from deficiency of monsoon rains than *Chloris* sp. In years of good rainfall the latter may form 34.57% of the crop but when monsoon rainfall is in deficit, it is unable to compete with *usar* and remains mostly depauperate. Samplings during the weighments in October 1944 from representative patches (when monsoon rains were deficient) gave the following proportions of grasses and other plants:

Usar	*Phulna*	*Cyanotis*	Miscellaneous†
60—85%	2—13%	7—21%	1—12%

A list of commoner plants occurring in the area will be found in the Appendix. on page 422.

Continued protection has gradually improved the area and many colonies of valuable fodder grasses like *Iseilima laxum* (*musel*), *Diohanthium annulatum* (*jargi*), *Cenchrus ciliaris* (*anjana*) etc. are now appearing. Such patches usually occur under isolated plants of *Calotropis procera* (Ak), *Melia azadirachta*

*Mainly *C. montana* and *C. barbata*.

†Mainly *Cyperus* sp. (*C. iria* and *C. aristatus*), *Cyonodon dactylan* and other grasses and dicotyledenous herbs.

(*nim*) or *Acacia arabica* (*babul*) or along depressions.

All around the land is heavily grazed and thus provides an excellent 'control' for comparison with the experimental area.

The effect of opening plot B to unlimited grazing was, that the cattle finished the grass crop in a short time and came to the area in comparatively smaller numbers later on. Records were kept of animals that grazed in the area during the years 1941-42, 1942-43 and 1943-44 and the average incidence was as follows:

Period		
October 1941 to June 1942.	4.5 units per acre	during 8 months of each year (October 16 to June 15).
October 1942 to June 1943.	4.8 units per acre	
October 1943 to June 1944.	5 units per acre	

Conclusions.

From the above results and observations, the following tentative conclusions may be drawn:

(*i*) That provided an area of this type is closed *during the monsoon*, the yield of grass does not appear to be affected by the incidence of grazing during the rest of the year. Controlling the incidence only leads to the better distribution of the grass crop produced during the monsoon.

(*ii*) Rotational grazing for one month followed by three months' rest, in rotation throughout the year, with an average incidence of one cattle unit per acre, leads to definite deterioration in yield. This appears to be due partly to grazing during one month in the monsoon in each section and partly also to concentration of cattle in the open sections, which causes more destructive trampling than in a periodically grazed area with the same incidence of grazing.

(*iii*) *Periodic grazing for eight months with closure during the monsoon is therefore to be preferred to continuous rotational grazing for one month at a time followed by three months' rest.* (*i.e.*, for a total period of three months in the year with the same incidence of grazing.)

APPENDIX
LIST OF COMMON PLANTS

1. Grasses

1. *Aristida adscensionis.*
2. *Cenchrusciliaris* (=*Pennisetum oenchroides.*)
3. *Chloris barbata.*
4. *Chloris montana.*
5. *Cyonodon dactylon.*
6. *Dactyloctenium aegyptium.*
7. *Desmostachya bipinnata.*
8. *Dichanthium annulatum.*
9. *Dichanthium caricosum.*
10. *Digitaria ciliaris.*
11. *Echinochloa colonum.*
12. *Eleusine aegytiaca.*
13. *Eragrostis tenella.*
14. *Eriochloa procera.*
15. *Heteropogon contortus.*
16. *Ischoemum rugosum.*
17. *Iseilima laxum.*
18. *Paspilidium flavidum.*
19. *Setaria glauca.*
20. *Sporobolus arabicus.*
21. *Sporobolus corcmandeliara.*
22. *Vetiveria zizanoides.*

2. Other Flowering Plants.

1. *Achyranthes aspera.*
2. *Aschynemone indica.*
3. *Ammania multiflora.*
4. *Aneilima nudiflora.*
5. *Boerhaavia diffusa.*
6. *Calotropis procera.*
7. *Caesulia axillaris.*
8. *Celosia argentea.*
9. *Chenopodium spp.*
10. *Corchorus acutangularis.*
11. *Cyanotis axillaris.*
12. *Cyperus cuspidatus.*
13. *Cyperus iria.*
14. *Cyperus flavidus.*
15. *Cyperus tuberosus.*
16. *Euphorbia hirta.*
17. *Fimbristylis miliacea.*
18. *Fimbristylis schoenoides.*
19. *Indigofera enneaphylla.*
20. *Ipomea pentaphylla.*
21. *Ipomea reptoans.*
22. *Jussieua spp.*
23. *Limnanthemum indicum.*
24. *Melia abedarachta.*
25. *Pluchea lanceolata.*
26. *Portulacca oleracea.*
27. *Portulacca sp.* (*near tubercsa*).
28. *Sesbania aculeata.*
29. *Trianthema crystallina.*
30. *Triumfetta neglecta.*
31. *Zornia diphylla.*

3. Cryptogams.

1. *Marsilia sp.* (in water).
2. *Nostoc muscurum* } On soil.
3. *Riccia discolor* }

Fig. 1.

Fig. 2.

Fig. 1.—**Populus nigra** Var. **fastigiata.** fossil leaf impression. R. R. Stewart Collection 1935, Registered No. N 50 Ningal Nullah. **Nat size.**

Fig. 2.—**Populus nigra** Var. **fastigiata,** fossil leaf impression. R. R. Stewart Collection 1935, Registered No. N 172 Ningal Nullah. **Nat size.**

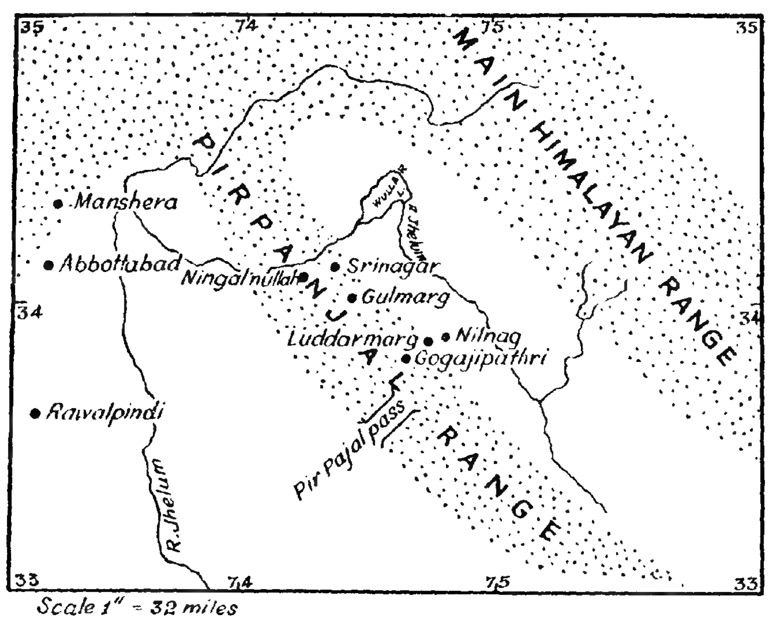


Fig. 3.

Sketch map of the Kashmir Valley showing the position of the fossiliferous locality on the Pir Panjal Range.

LOMBARDY POPLAR (*POPULUS NIGRA* LINN. VAR *FASTIGIATA* DESF.) IN INDIA

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Introduction.

The study of fossil plants often throws important light on knotty phytogeographical problems and sometimes furnishes important data which can help to explain the origin, even in limited geographical areas, of individual species of plants or plant-groups. Students of living floras accustomed to look at plants only in their present distribution are often unable to appreciate their existence in time and, being unaware of their geological history, advance arguments to explain the origin of plants which do not find support from palaeobotanical quarters. In the present note the author endeavours to show that the Lombardy poplar, the pyramidal variety of *Populus nigra* Linn.—which is commonly planted in Kashmir and north-west India and is believed to have been introduced into this country from Asia—is probably indigenous to India, and that its existence in Kashmir is perhaps as old as early Pleistocene times.

The Lombardy poplar is regarded of a doubtful origin; some authors consider it to be a native of Italy, while others believe that its home was in America; "it is said in Persian works to be a native of Dailim and Tinkaboon, near the south shore of the Caspian" (13, p. 344). J. L. Stewart (15, p. 472) on the other hand, considers that although the Lombardy poplar has been cultivated in Italy since very long, "it is not, however, mentioned by classical writers, and must have been brought from Asia by the Arabs or at a later period." From Italy it is thought to have been introduced into France in 1749 and into England in 1758 (15, *loc. cit.*). The idea of its origin from somewhere in western Asia is held by most of the authors; however, no one has furnished any proof in support of such a view.

According to Berry (1, p. 89) the Lombardy poplar "is probably of Oriental origin despite its name, coming originally from the region of the vale of Kashmir," and according to the "Encyclopædia Britannica" (6, p. 227) "it was unknown in Italy in the days of Pliny, while from remote times it has been an inhabitant of Kashmir, the Punjab and Persia where it is often planted along roadsides for shade," and as we shall see presently these two observations are welcome support to our contention that the Lombardy poplar is indigenous to Kashmir.

Palaeobotanical Evidence

The palaeobotanical evidence is solely based on the discovery, by the author (10, p. 24; 11, p. 88, and 11 a) the Karewa deposits of Kashmir, of a few well preserved leaf impressions, which are specifically identical with modern leaves of the graceful Lombardy poplar (*Plate 10, Figs. 1 and* 2). This unmistakable occurrence of the species in the Kashmir Valley during the Pleistocene would lead one to question the common belief long held by systematists (3, p. 640; 7, p. 638; 8, p. 511) that this plant is not wild in India but has been recently introduced and occurs only as a cultivated tree in this country.

Fossil leaves of *Populus nigra* are commonly known from the Pleistocene deposits of Europe. In an important paper on the Flora of the Quarternary Period Principi (9) has mentioned that *Populus nigra* has been recorded from the glacial deposits of France (p. 25), Switzerland (p. 44), Italy (p. 60) and Lombardy (p. 63). The discovery of *P. nigra* in the Pleistocene deposits of Europe is equally interesting.

The plant-bearing beds which have yielded our fossil leaves together with a rich fossil flora of willows, walnuts, alders, cherries, horse-chestnuts, etc. (10, *loc. cit.*; 11, *loc. cit.*) are exposed at numerous places along ravines or hill-streams in the upper Ningal valley (34° 4′N.; 74° 9′E.) at an elevation of 9,000 ft., on the northern slopes of the Pir Panjal Range (*See map in plate* 10, *Fig.* 3). These strata are assigned a Pleistocene age by De Terra and Paterson (5, plate 55). The available evidence goes to show that the Lombardy poplar must have been fairly well represented in the Kashmir valley during the Pleistocene, where it was associated with a type of vegetation which still grows to-day near the fossiliferous localities under a temperate climate.

Therefore, its present discovery is both interesting and significant not only because it seems to throw important light on its history in India, but it also indicates that the valley of Kashmir, especially near Ningal *Nullah*, had at one time (during the Pleistocene) experienced a temperate climate essentially similar to what we find to-day in this region (10, *loc. cit.*; 11, *loc. cit.*)

Modern Distribution of *Populus Nigra*.

The Lombardy poplar, which "derives its popular name from its abundance along the rivers of Lombardy where it is said to spring up naturally from seed" (6, *loc. cit.*), is usually described as a variety (*fastigiata* Desf. or *pyramidalis* Spach.) of the black poplar, *Populus nigra* Linn. (7, p. 638; 8, *loc. cit.*). However, it has been given a specific rank by other authors and variously described as *P. italica* (12, p. 10), *P. dilatata* (13, *loc. cit.*) or *P. pyramidalis* (4, *loc. cit.*). It is successfully cultivated in England, in the U.S.A., and several countries in southern Europe, where it is supposed to have been brought from Kashmir, the Punjab and Persia (6, *loc. cit.*).

Although the occurrence of the Lombardy poplar at some places in Kashmir and north-west India is almost gregarious, so far as we know it does not occur in the wild state in the valley. As a cultivated plant it flourishes here at altitudes of 5,200—6,000 ft., chiefly as a roadside tree. The graceful poplar avenues on the Jhelum valley road from Baramula to Srinagar and along the roads leading from Srinagar to Tangmarg and Pahlgam are too well known to need any description. It is also planted into hedges or screens round houses or fields. On the adjoining mountains both on the northern slopes of the Pir Panjal Range and the southern slopes of the main Himalayas it is successfully cultivated up to an altitude of 10,000 ft. and ascends to an elevation of over 12,500 ft. in western Tibet. It grows wild in western Asia and its reported occurrence by Griffith (15, *loc. cit.*), in a wild state at Shekhabad near Kabul at an altitude of 7,500 ft. is especially interesting because in the neighbouring regions on the east, namely Hazara, Murree Hills, Kashmir, etc., it is supposed to occur in cultivated state. Unfortunately the fossil history of the Lombardy poplar at Kabul or elsewhere in India is not yet known, but on account of its occurrence, though in a cultivated form, at many places in Hazara and Murree hills—regions intervening between Kabul and Kashmir—one may suggest that the invasion of this species from western Asia probably took place through this route.

Discussion.

If the testimony of palaeobotany is to be accepted the theory of the recent introduction of the Lombardy poplar into Kashmir would become untenable, unless it is assumed that this species, having once become extinct in this region, has since been re-introduced by man. Such an assumption may seem at first to find support from Berry (2, p. 324) who with his vast knowledge of the Cenozoic floras, especially of America, is of the opinion that Tertiary plants, which have once become extinct from a certain region by a sudden change in climatic conditions can again gain their foothold in those regions with a remarkable ease if re-introduced either by natural or artificial agencies. He writes (p. 324) "A thousand such illustrations could be given. Perhaps the most striking is furnished by Europe. Nearly all the American or Asiatic plants which are no longer natives of Europe, but whose ancestors were there in the late Tertiary will flourish when reintroduced by man." Without commenting on Berry's theory, it may be pointed out that out of a total of nearly 40 fossil species recognised from the Ningal *Nullah* locality, all excepting *P. nigra*, var. *fastigiata* are generally believed to be indigenous to our country. One might reasonably ask what special reason is there for the view that the Lombardy poplar has not existed in the Kashmir valley since the Pleistocene?

There seems to be no evidence that the climate of the valley near the Ningal *Nullah* locality has materially changed since the Pleistocene; and this idea is supported by the fact that practically the same association of species, composed mainly of willows, poplars, cherries, walnuts, etc., discovered in the fossil state at this place are now found living in this region. It therefore seems that the idea of the continued existence of *P. nigra* var. *fastigiata* in Kashmir since the Pleistocene times gains distinct ground and we may be allowed to differ from the common belief that the Lombardy poplar is not indigenous to our country and that it was introduced into India in modern times.

According to an important theory advanced by Professor Sahni (14, p. 114), the modern conifer flora of the north-western Himalayas migrated to our country from the north-west at the beginning of the Pleistocene when our Himalayan mountains after the Post-Pliocene uplift were just suitable for the growth of these plants. In the light of the above facts one feels tempted to suggest that *Populus nigra* also may have migrated to our country at about the same time from somewhere in western Asia.

In the end I wish to record my most sincere gratitude to Prof. B. Sahni, SC.D., F.R.S., for helpful criticism of this note.

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GRAZING AND PASTURE RESEARCH IN THE CENTRAL PROVINCES*

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The experimental work done so far in the Central Provinces and Berar is summarised below:

2. With continuous and unrestricted grazing, the grazing grounds tend to deteriorate. Periodic closures and control of incidence is believed to increase the productivity. In the absence of any data to show optimum grazing closure cycles and incidences, they were arbitrarily fixed and experiments were initiated to see if the prescribed restrictions were actually improving the yield or not. In 1931, a number of one-tenth acre grass plots were laid out in various localities. The yield from them was determined when hand-mown at intervals and when only one cutting was done towards the end of the growing season. The data collected failed to give conclusive evidence whether one cutting or several cuttings were more productive. Fresh plots were laid out in 1932 and assessed. But again the figures failed to produce reliable results. It was realised that the investigation was subject to many vitiating influences and conclusive indications could only be obtained if the experiments were conducted on a large scale for a number of years under the supervision of trained officers.

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*Paper communicated by the Chief Conservator of Forests, Central Provinces and Berar, to the sixth Silvicultural Conference, Dehra Dun (1945), on item 8—Grazing and Pasture Research.

3. In 1934, a detailed investigation was commenced in the grazing grounds of Saugor and Yeotmal in consultation with the central silviculturist. The treatments under comparison were three intensities of incidence, three site qualities and various grazing closure cycles varying from 1 to 10 years. The layout of the plots was designed to ensure initial comparability and to eliminate the effects of seasonal variations. Nearly 150 one-tenth acre plots were thus assessed during the years 1934–37. An analysis of the data once again showed that the effect of uncontrolled variables completely swamped the variations due to treatments under study. Thus even this elaborate investigation failed to give definite indications regarding the effect of closures on grass production. It however taught us a number of lessons which are detailed on pages 287 and 288 of the proceedings of the silvicultural conference held in 1939. The chief lesson learnt was that in intricate investigations like regulation of grazing, many vitiating influences such as heterogeneity of the area, climatic variations, etc. are to be contended with. The experiments must be on a large scale and spread over a number of years.

4. The first obvious step was to evolve a technique for correctly assessing the productivity of any area by an inexpensive method before the effects of two treatments can be compared inasmuch as the treatments must be applied to strictly comparable samples. In 1938, therefore, a fresh investigation was started with a view to find out technique for assessing the comparative productivity of plots of convenient size, *viz.*, 66′ by 66′ and also to determine the number of replications required. An area of about 12.5 acres of grazing ground near Nagpur was selected. The area was divided into 66′ by 66′ plots. After trying several methods of assessment and assessing various percentages of the plots on different sizes of quadrats, eventually a practical method has been evolved which is summarised below.

5. An area of not less than 6 acres, *i.e.*, sufficient to get 30 replications of the pasture covering the entire range of variations should be selected when the comparative merits of two treatments are to be assessed. The entire area should be divided into 66′ by 66′ plots. Fifty per cent. of these plots selected by drawing lots should be allotted to one treatment and the remaining 50% to the other. Each of these plots may be assumed to be divided into 100 quadrats 6.6′ by 6.6′ by lines parallel to the plot boundaries.

6. After the treatments have been applied and the grass is ready for harvesting—preferably just before seed has ripened, *i.e.*, about November-December, 25 quadrats 6′-6′ should be laid out in each plot by drawing lots and the herbage in each assessed occularly. In the Nagpur Pasture Investigation, the following data was recorded by occular estimation :

I. Density of stocking.

Very sparse	..	0—50 per cent. stocked.
Sparse	..	50—75 per cent. stocked.
Thick	..	75—100 per cent. stocked.
Very thick	..	over stocked.

II. The prevailing type of herbage.

(*a*) Important fodder species :

(*i*) *Sheda* (*Schima norvosum*, stapf.)
(*ii*) *Mushan* (*Iseilema laxum*, Hack.)
(*iii*) *Marvel-lahan* (*Dicanthium annulatum*, A. Cassus).
(*iv*) *Marvel mothi* (*Dicanthium caricosum*. A. Cassus).
(*v*) *Bhuijuar* (*Alysicarpus rugosus*).
(*vi*) *Sheora* (*Indigofera linifolia*).

(*b*) Less important fodder species :

(*i*) *Kusal* (*Heteropogon contortus*, Beauv.)
(*ii*) *Ghonad* (*Themeda quadrivalvis*, O. Ktze.)
(*iii*) *Diwartan* (*Andropogon pumilis*, Roxb.)
(*iv*) *Gadhasheda* (*Chrysopogon montanus*, Twin.)

(*c*) Non-fodder species collectively.

III. Percentage area occupied separately by species in the case of types (*a*) and (*b*) and collectively for all species in the case of type (*c*) mentioned above and the percentage of the unoccupied area.

7. Before the experiment was started it was decided that a 10% significant difference between two treatments would be accepted as showing the superiority of one treatment over another.

8. The above technique can be employed for comparing the effects of such treatments as burning, weeding at various intensities, harrowing, manuring, reseeding, etc. This technique however cannot be employed for treatments involving grazing or mowing of grass. Further experiments are needed to find out a suitable technique for such treatments.

9. Besides the above experiments, certain subsidiary investigations were also carried out. These and the indications obtained from them are given below:

(*a*) Chemical composition of various fodder species found in the pastures.

Representative samples of certain important species were selected from good and poor localities and chemically analysed. The analyses show that there is no appreciable difference due to locality factors so far as the organic nutritive constituents are concerned but certain species such as *nushan* (*Iseilema laxum*), *diwaratan* (*Andropogon pumilis*) and *marvel-mothi* (*Dicanthium caricosum*) when grown in good locality are somewhat richer in phosphoric acid than when grown in poor locality. As regards the nutritive value as judged from the non-mineral nutritive constituents of individual species for a given weight of herbage, *diwaratan* (*Andropogon pumilis*) was the best but in the basis of the mineral and non-mineral constituents together, *marvel-lahan* (*Dicanthium annulatum*) was the first followed by *marvel-mothi* (*Dicanthium caricosum*), *nushan* (*Iseilam laxum*), *kusal* (*Heteropogon contortus*) and *sheda* (*Schima nervosum*). On the basis of dry matter and total food units yielded per acre *kusal* was the best though somewhat poor in phosphoric acid and protein contents showing thereby that if the species is cut a little before the dead ripe stage, it is a valuable fodder. The prejudice against it is mainly due to its being harvested at a period when its lawns have hardened.

(*b*) Soil samples collected and analysed for mechanical composition, organic carbon, nitrogen content and pH value from "good" and "poor" sites as adjudged by the herbage growing thereon showed that difference is not appreciable. It would thus appear that the quality of herbage depends on (*i*) the moisture content of the soil which is greater in deeper soils and lasts longer, (*ii*) the volume of soil tapped by the fodder species.

(*c*) Samples from herbage collected from areas carrying the following types of pastures were analysed:

(*i*) best type found on fairly heavy and moist soils (*nushan*, *marvel* consociation;)

(*ii*) medium type found on coarse but still fairly deep soils (*sheda-kusal* consociation), and

(*iii*) poor type occurring on very poor and shallow soils (*bhurbhuri-diwartan* consociation).

These showed that there was no correlation between total exchangeable bases and the nutritive value of the herbage produced. The variation is due to causes other than the mineral composition of the soil, probably due to moisture contents.

The herbage was also analysed for mineral and non-mineral constituents and the value of food-units. These analyses did not justify any useful conclusions. In fact they failed to show the comparative obvious merits of the three types.

(*d*) *Succession.*— Changes in the composition of herbages were also noted as a result of closure and annual cutting after seeding. These showed that in the first year or two the proportion of *Cassia tola* decreased and that of *kusal* (*Heteropogon contorus*) and *sheda* (*Schima nervosum*) increased. In the next year *sheda* increased suppressing even *kusal* but allowing *nushan* and *marvel* to come underneath it. At this stage the pasture is at its best. It begins to deteriorate on further closure as the coarser grasses (*Themeda quadrivalvis*) and *phulkis* (*Alpuda varia*) appear and begin to spread.

10. The problems of immediate importance to this province requiring investigation are:

(*i*) Determination of a suitable technique for assessing pastures when the treatments to which they are subjected involve grazing or hand-mowing of herbage.

(*ii*) Determination of the effect of the following treatments on pastures with due regard to the costs involved.

(*a*) Burning before the growing season.

(*b*) Shrun-cutting and weeding of non-fodder species.

(*c*) Draining, soil working and manuring.

(*d*) Closures to grazing for 1, 2, 3 and 4 years respectively and annual grass cutting just before the dead ripe stage.

(*e*) Effect of division of the pasture into blocks and permitting grazing in the blocks for a day, say on 7 days cycle.

(*iii*) Determination of the optimum grazing closure cycle.

(*iv*) Determination of the effect of control of incidence.

11. It is suggested that a special section to deal with pasture and grazing problems should be created and put in charge of an agrostologist as the silviculturist has a number of other problems to investigate. The agrostologist should be provided with adequate staff, funds and equipment to efficiently carry on the work entrusted to him.

OUR LAWNS AND THEIR RECONSTRUCTION *

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I am pleased to have this opportunity of discussing the subject of our lawns and their reconstruction. A great deal has happened since I gave my previous paper on the more scientific aspects of lawn management in 1938, but the end of the war is coming into sight, the dark days are passing, and we are now surely justified in thinking ahead and planning for the future of our turf.

What is primarily required is *practical* advice in order to help to re-make neglected or destroyed lawns, or to put back to grass those swards that have been dug up and used for food growing. I look upon the present time as a golden opportunity to effect major improvements to the lawn and to put right those things that we may have wanted to do in the past but could not bring ourselves to carry out, and I shall bear in mind very largely the needs of the amateur gardener.

There is no doubt that a good lawn determines the character of a garden and can make or mar the general landscape architecture. Unfortunately many amateur gardeners, and perhaps some professionals too, expect the lawn to look after itself, except for occasional rolling and mowing; they fail to realize that the creation of good turf requires regular work and as much care as any other collection of plants growing in association, for indeed that is what a lawn is—an association of plants competing for space, yet continually mown and often trampled upon. If the balance is upset, low growing plants, other than grass, may make their appearance and compete on better terms than the grass.

Let us examine first of all some of the causes of past failures; they may be summarized as follows:

1. Cheap or hasty preparation of the site.
2. Insufficient or incorrect preparation of the soil for the reception of the grasses.
3. The sowing of (*a*) impure seed, or (*b*) seed of low growth, or (*c*) seed of the wrong species.
4. Uneven sowing.
5. (When using turf) choice of bad turf and laying it unevenly.

When a lawn has been established deterioration sometimes sets in and the causes of such decline are as follows:

1. Abuse of the roller.
2. Use of an old or ill-set mower.
3. Wrong manuring.
4. Heavy wear and tear.
5. General neglect.

What is the ideal lawn? What do we expect to find and what should be our ultimate goal? First of all we must try to obtain uniformity in colour and texture. The surface must be true, for even if the lawn is purely for ornamental purposes a true surface is required; without this the mowing cannot be even and mowing largely determines uniformity, density, texture and colour. Then again we must aim to have a weed-free turf. We must also have grasses present that will blend and not appear in irregular patches. Furthermore, no lawn can be uniform and neatly mown if infested with earthworms. Freedom from soil pests and fungal diseases are further ideals. The lawn should not only look well and feel resilient to the foot, but it should blend into its surroundings. Also, we should try to achieve some degree of drought resistance and a capacity to retain a reasonable condition during the winter months. The ideal is indeed exacting. The conditions required are so definite, however, that the botanical species suited to a lawn are very much restricted. Indeed the conditions, imposed mainly by the mower, often decide the grass and weed species capable of growing in turf.

Let us now proceed to some thoughts on the practical aspect of restoring lawns that have been neglected, or used for food growing during the war. Take first of all the case of the lawn that has been dug up and used for crop production, perhaps for three or four seasons. I think the best advice I can give is to aim for autumn sowing. A good way of doing this is to grow a crop of early potatoes, which should of course be manured with compost of farmyard manure, well cultivated, and dressed with a suitable potato manure containing phosphate, potash and nitrogen. If this is not practicable, other early crops, *e.g.*,

* *Lecture given on March* 20, 1945; *Professor F. E. Weiss in the Chair.*

salads, early carrots, and perhaps early peas, could be grown, the aim being to have everything clear by about the middle of August. In other words, main crops which would carry on into September and the autumn and early winter should not be planted. This I consider from all points of view—food production and preparation—the best plan and it is preferable to a bare fallow. Another method, however, is to dig the site, roughly to prepare the surface in spring, then to sow White Mustard or Rape or Italian Rye grass and when these crops are 3 or 4 inches high to roll them down and dig in, then fallowing the land and generally preparing it as will be described later, in readiness for the autumn sowing. The chief advantage, as I see it, for the planting of an early Potato crop is that it provides an opportunity for thorough cultivation and cleaning, and also an opportunity of treating the land generously with phosphate, potash, and nitrogen, of which the residue will be of assistance in establishing the new sward. I stress this point because under present regulations neither phosphatic nor potassic manures may be used for lawn treatment, but I can see little objection to the manurial residues being utilized for this purpose. Although the embargo on the use of all other fertilizers for lawn purposes, as well as sports grounds, has been lifted, it must be realized that all fertilizers are scarce and are primarily needed for food crops. Much can, however, be done on small lawns with various by-products and small amounts of non-controlled fertilizers.

In re-making a lawn it must be realized that the turf will probably be down for many years, therefore this is a unique opportunity to improve the soil in all ways possible prior to the establishment of the new turf. Thorough cultivation is a first necessity, and in the case of heavy soils further improvement should be made by incorporating coke breeze, coarse sand, well rotted organic manure, granulated peat, and materials of this type, to provide a friable soil approximating as far as practicable to a medium loam. In the case of very light soil, organic manures will help, as well as peat and similar moisture-retaining materials.

There are two ways in which the lawn may be established, either by seeding, or by turfing, and later we shall proceed to describe methods to be adopted in each case, but assuming the site is to be cropped for the early part of the season, the aim should be to sow the seed about the last week of August or in the South the first week in September. In the case of turfing, the work can be carried out in the winter, preferably finishing it by December before the winter frosts commence in earnest. A turfing scheme gives a longer cropping period but does not solve the problem of finding good turf.

We have been considering so far the lawn site that has been growing food; there are, however, many lawns that have not been cultivated but have deteriorated very seriously. In some cases the turf has been completely abandoned, possibly because the owners have been away. Spring is the right time of the year to start work in these cases. Perhaps one of the best ways is to try to burn off as much of the old matted grass as possible. Alternatively, or after the burning, rough mowing should follow. For this purpose the small lawn owner will doubtless use the shears, but it is very tough going. On larger areas scything or reaping will be best, followed by the side wheel mower. Dead and partially dead, matted grass should be raked off and indeed the whole surface would benefit by raking with a wire rake. Some rolling will then be necessary and it is a good opportunity to apply a dressing of sand or fine breeze to the surface which has no doubt become uneven through the action of earthworms and possibly moles and other pests. In the case of lawns that have been abandoned the probability is that many of the lawn weeds, so common to regularly mown turf, will have been smothered out. It is unusual to find weeds like Daisy, Mouse-ear Chickweed, Selfheal and Pearlwort under these conditions. At the same time stronger growing seeds like Dandelions, Thistles, and the taller growing grasses like Cocksfoot and Holcus may have become aggressive. Large tufts of Cocksfoot are difficult to deal with, but they should be hacked off close to the ground and it will be found that they die out by degrees under the influence of the mower. In the case of patches of Holcus of which two species, Yorkshire Fog and Creeping Soft Grass, may be involved, raking and re-seeding will be required, but if these grasses dominate the sward there is much to be said for complete reconstruction.

Then there are the lawns that have been mown occasionally but have received no dressing. They are probably looking very thin and poverty stricken and perhaps invaded by moss as well as many of the other lawn weeds like Daisy, Selfheal, Chickweed and so on. In these cases the owner has to decide

whether he thinks it possible to resuscitate the turf by surface treatment or whether he will embark upon a major operation involving the digging in of the old turf and complete reseeding. It is impossible for me to make a decision on this point without seeing the turf, but factors to bear in mind are the nature of the grasses present in the neglected turf and the general condition of the turf, and knowing what it was like prior to the war. If there is present a good stand of Bent grass or Agrostis in the turf, there should be no insuperable difficulty in encouraging it and gradually eliminating the weeds by surface treatment aided by hand work. If, however, there is a very large proportion of weed and a great deal of Yorkshire Fog and other coarse grasses and the land is very heavy, or very sandy, then a new start should be made. In these cases the best plan is to dig the lawn, turning the turf over and burying it; bastard trenching is an advantage. In some cases lawns will have developed too high a degree of acidity during the war period; this is especially likely to be the case in the neighbourhood of industrial areas and large towns. Some degree of acidity of soil is desirable for fine turf, but if the pH of the soil is below say 5 to 5.5, light liming would be desirable. In some cases neglected lawns will be very matted with an accumulation of dead and semi-decayed fibrous material on the surface; in these cases vigorous raking with a wire rake should be done. Much of the weed control can be achieved by means of sulphate of ammonia and sulphate of iron, as will be described later.

So far I have endeavoured to indicate the general lines upon which neglected lawns should be dealt with and broadly how to restore a site which has been under cultivation for crops. Let us now go into the various operations in greater detail. The first thing in making a new lawn is to consider the question of drainage; if the land is heavy, or the site is inclined to lie wet, now is the time to introduce a system of drains, the form of which will of course depend largely upon the configuration of the land. On some very heavy soils the best results can only be obtained by removing a layer of top spit, introducing a bed of clinker and ash, and restoring the top spit to its correct position. Naturally this is a costly procedure and should only be attempted on very heavy land, but it is frequently done on bowling greens and quite often on tennis courts and some sports grounds where it is desired to play games as soon as possible after rainfall. As regards drainage, there are four main factors requiring consideration; the depth of the drains, their distance apart, the fall, and the outlets. For draining lawns a depth of 1 foot 6 inches to 2 feet is usual with a fall down to 2 feet to 2 feet 6 inches; a fall of 1 in 100 is usual but on larger areas 1 in 300 is effective. On medium soils the drains may be rather deeper and on sandy loams, if they require drainage at all, 3 feet to 4 feet is suitable. The distance apart of the drains is also determined by the nature of the land, they may be as close as 10 feet apart, but on a medium soil 25 feet, or on more open soils 30 to 50 feet. A herring-bone system of drainage is usually chosen but in all cases it is essential that a free outfall be provided, otherwise silting up soon takes place. On small areas in towns where a system of this type is impracticable, much could be done by a system of sumps filled with broken stones and with a few short drains radiating into them. After the tile drains are laid, broken stone, clinker and a layer of ash should follow. The soil should be 4 to 6 inches deep overlying the layer of ash.

The next matter is the choice of suitable seeds. Many lawn owners think of nothing but price, buying a cheap mixture which by very reason of its price is bound to contain perhaps 50 per cent. of perennial Rye Grass and, although the establishment may be good and the general effect at the start encouraging, the ultimate results will be most disappointing. It is therefore important that, having gone to a great deal of trouble to prepare the foundation of the lawn, a good seeds mixture be utilized. Experimental work has shown that it is possible to establish an excellent lawn from one species only or two species sown in combination. A very suitable mixture is:

7 parts by weight Chewing's Fescue
3 ,, ,, Browntop or Bent.

Both these seeds come from New Zealand and reasonable supplies are available. As a matter of passing interest about 15,000 acres of Fescue were harvested in New Zealand in 1943 and 10,000 acres of Browntop. In normal times a proportion of Creeping Red Fescue may be included in the above mixture but supplies at the moment are very scarce. On the lighter soils 5 per cent. of smooth-stalked Meadow Grass might also be included. The above

seeds should be sown at $1\frac{1}{2}$ to 2 oz. per square yard, that is on the assumption that seed of high purity and growth is obtained. Chewing's Fescue has an unfortunate habit of loosing its power of germination, either in transit or after reaching this country, and sometimes the seed is of low growth. A guarantee of growth should be obtained. Naturally only seed of high purity should be purchased and it should be borne in mind that, at a 2 oz. per square yard seed rate, even a small percentage of weed impurity by weight amounts to a large number of weed plants per square yard. Perhaps the following will make this clear. If a sample of Chewing's Fescue contains say 0.2 per cent. of perennial Rye Grass by weight as impurity and the Fescue is sown at 2 oz. per square yard, this will mean 50 potential Rye Grass plants per square yard. These would destroy the appearance and quality of the sward. This same weight of impurity as Chickweed, *viz.* 0.2 per cent., would entail planting 1,000 seeds of this pest. A seed sample quoted as 99.5 per cent. pure may be satisfactory if the remaining .5 per cent. is chaff but very dangerous if this balance is harmful weed. When sowing these two seeds together there is unfortunately a tendency for them to separate out because of the disparity in size. Also one tends in raking in the bigger seed to bury the finer too deeply. Quite a good method is to sow the Fescue separately. To do this $1\frac{1}{2}$ oz. per square yard of the Chewing's Fescue should be lightly raked into the surface with a wire rake. The Browntop or Bent seed should then be sown on top at $\frac{1}{2}$ oz. per square yard, mixed with some sand to aid distribution. This should be worked in by simply dragging a flattened dry sack over the surface. This works the small seeds into the crannies between the soil particles. The surface should then be lightly rolled, or gently patted with the back of a spade. We have sown many experimental plots in this way and found it to be very effective.

Chewing's Fescue is a wiry-leafed grass of which the colour is unfortunately not too good during the winter months and by reason of its toughness it tends to give trouble in mowing unless the machine has been very carefully sharpened and set. There is much to be said, therefore, for establishing a lawn of New Zealand Browntop only. In practice this has been done in many cases but results are often slow to come at the start. The seed of Browntop is very small—there are about 5 million to the pound; the seedling is therefore correspondingly small and so takes longer to establish. Chewing's Fescue, when sown with Browntop, has the advantage of acting as a nurse crop to the Browntop and from the lawn owner's point of view the soil is grassed over much more rapidly. Eventually, except on very light land, the Fescue is ousted by the more aggressive Browntop. For those who are able to prepare a good fine seed bed containing reserves of plant food, there is much to be said for the one-grass lawn, using New Zealand Browntop at $\frac{1}{2}$ oz. per square yard. In experienced hands as little as $\frac{1}{8}$ oz. per square yard may be utilized, since it should be realized that $\frac{1}{8}$ oz. of this variety contains about 40,000 seeds and potentially this number of plants per square yard. Establishment is often incomplete.

It may be argued that the above simple seeds mixture, or single sowing of grass is unsuitable to meet the wide range of soils likely to be encountered up and down the country. In practice, however, sowings of these seeds have been satisfactorily employed under a very wide range of soil conditions, but the view is expressed that it is preferable when sowing a lawn to modify the soil as much as possible so as to try and make it suit the seeds mixture. At the moment there is very little choice in the matter of seed, as none of the European grasses, like Hard Fescue, Fine Leaved Fescue, and rough-stalked Meadow Grass, are available. I have already mentioned Rye Grass seeds mixtures and only on large areas like sports grounds, or where conditions of cost preclude the non-Rye Grass mixture, should they be used. A Rye Grass mixture is very useful for a lawn that is required as a playground or as a drying lawn but is not satisfactory for producing the best type of ornamental sward. Where Rye Grass mixtures are used, a proportion of the seed should be in the form of an indigenous or a leafy strain which is of more permanent value than the ordinary types of Rye Grass. Some non-Rye Grass mixtures, consisting basically of Chewing's Fescue and Browntop, have in them also 5 per cent. or 10 per cent. of Crested Dogstail; this grass does not blend with Fescue and Browntop.

Under extreme conditions of soil certain modifications of seeds mixtures may be desirable but we are much restricted at the moment in view of the absence of certain species from the market. On very acid soils, for example,

additional grasses would normally be included. Establishment of grass under trees usually presents difficulties and here the inclusion of Rye Grass and Crested Dogstail with the seeds mixture already given is an advantage.

The fine seeds referred to must be sown uniformly and the seed is best divided into several lots and the ground covered an equal number of times. Seeding should always be done on a dry surface and the seed carefully worked into the soil. On larger areas some mechanical method of seeding will be required, either a small distributor, or fiddle seeder. Given good germinating weather the seedlings should be through in from five to ten days and if the soil has been well cultivated and is in good heart the grass will grow rapidly and soon require topping with the mower. The first cut is best done when the grass has reached a height of two inches and approximately half-an-inch should be removed. There is no advantage in leaving the grass until it is longer and much harm is frequently done by this unfortunate practice. Some articles on lawns recommend that the seedlings be scythed at this stage, but I have yet to find the amateur gardener who is capable of carrying this out. It is best to use a well-sharpened, side-wheel mower.

Even though great care may have been taken in preparing a seed bed and in buying clean seed, it may happen that a number of annual weeds will appear, in the turf. Weeds like garden Chickweed and Groundsel sometimes occur, but it will be found that these gradually die out as a result of regular mowing; they are not normal lawn weeds and are incapable of withstanding regular clipping. It is much more important at this stage that the lawn owner should concern himself with the removal of stray plants of other grasses like perennial Rye Grass, Cocksfoot, or Yorkshire Fog, that might have been introduced in the seed or were more probably present in the soil in a dormant state.

After the lawn has been mown for the first time it is sometimes desirable to roll lightly, and at this stage also a top-dressing of finely-screened compost, containing a proportion of sand and very fine peat, is an advantage. If the turf is pale or discoloured it may be due in part to the effects of the first cut, but if it does not show signs of recovery after a short time it may be due to nitrogen deficiency, and when this is the case a light top dressing with compost containing sulphate of ammonia at $\frac{1}{4}$ oz. per square yard may be given, or the sulphate may be given in solution. Another material of use for this purpose is nitro-chalk which can readily be broadcast over the surface.

I have used above the words "top dressing," by which I mean all those types of dressings of a bulky nature which are relatively low in plant foods and I do not include artificial manures. The dressing is applied to the surface of new or old lawns; the primary benefit being the filling of small hollows and general improvement of the surface. This facilitates mowing and helps to build up a strong mat of fibre or turf on the surface. Careful top dressing is one of the most important features of modern lawn upkeep. Top dressing material can be varied; it may consist solely of sand applied in the autumn to the heavier types of soil, or it may, especially if given during the growing season, consist of finely-prepared composts containing sand, fine peat, dried digested sewage and a proportion of soil. The soil is of course better sterilized, which introduces a big subject and one which we can hardly touch upon at the present time. The material should approximate in quality to a good potting soil. Top dressing of this type is also a very useful vehicle for the distribution of the more concentrated plant foods. Much damage can be done by attempts at distributing raw fertilizers, but if they are bulked with seven or eight times their weight of top dressing compost only very careless distribution is likely to cause damage to the turf.

As the young lawn develops more frequent mowing will be required, but in the case of a newly-sown lawn put down at the end of August, or early September, it may not require more than say three light mowings before the colder weather sets in and checks growth. The grass should not, however, be allowed to grow long during the winter but should occasionally be topped with the machine in open weather. There is no necessity to cut ornamental lawns so keenly as bowling greens or putting greens and a good measure is a width of about $\frac{1}{4}$ inch between the bottom of the sole plate and a line drawn between the front and back roller of the mower. Mowing is one of the most important factors in turf management, and it is keen and frequent mowing that very largely encourages weeds.

The constant defoliation of the grass reduces its aggressiveness so much that it causes an opening of the sward which then allows weeds to come in. Such invading weeds are always those types which are able to spread and propagate themselves below the level of the bottom blade of the machine. The ideal for lawn maintenance is to mow frequently but not keenly—perhaps two or three times per week during the growing season. In this way the maximum production of shoots can be assured, with stronger root growth and maximum competition against weed invasion. The worst thing one can do in mowing is to let the turf grow long and then hack it all off together as a special Saturday afternoon job. Naturally in mowing the lawn care must be taken to ensure that the machine is carefully set and especially is this so with newly-sown turf. Better results are obtained by cutting when the grass is dry, and in dewy weather this condition can be encouraged by "switching" off the dew some time prior to mowing.

On many lawns one finds bare places which on close examination are found to coincide with lumps and ridges. They have been skinned by the bottom blade of the mower coming into contact with them as the front roller passes down on the far side of the lump. This indicates that the lawn has been badly laid in the first place or has settled. This fault can be corrected by occasional rolling, by frequent top dressing of hollows, and in severe cases by opening the turf on the affected part and setting it lower.

It may be as well at this point to say something about the making of lawns from turf. Much of what I have already said has been concerned with the establishment of new lawns from seed, and I think on the whole this method is to be preferred because in urban areas it is very difficult to obtain a satisfactory type of good turf for the establishment of a fine lawn. If, however, good turf can be obtained it should consist primarily of plants of Bent (Agrostis) with relatively little weed. Turf that has received some preliminary treatment *in situ* before lifting is to be preferred. Sods are often offered by builders consisting of irregular lumps of turf with the grass perhaps 3 to 4 inches long, these are not really satisfactory and are the cause of much future trouble. Good turf should be uniformly lifted, it should be 1 to $1\frac{1}{4}$ inches thick and should be in pieces of 2 or 3 feet by 1 foot. If the turf has been badly lifted it should be boxed, that is, it should be inverted in a shallow tray and the excess soil pared off to give a uniform thickness. By doing this much trouble is avoided when relaying, because the turf bed can be carefully raked into a level condition and the new turf laid on it with the minimum of packing. It is a wise plan to pre-treat the soil with fertilizer before laying turf, because this encourages rapid root development and the turves are soon fixed down. Experiments have shown that the thinner the turf, within reason, the more rapid the establishment. When the new turf has been laid a heavy dressing of sand should follow and this should be worked into the cracks and seams in the turf. Rolling with about a 2 cwt. roller should follow after rooting has commenced.

On the subject of rolling much could be said. The roller is often abused; it is used in an endeavour to eliminate lumps by pressing them down to the level of the hollows and this leads to excessive compression and very rarely completes the work. Better results are obtained by rolling only occasionally and by top dressing the hollows to raise them to the level of the ridges. On most lawns it is sufficient to roll once or twice in the spring and later to depend upon the roller mower as the means of compression.

On lawns that have become hide-bound or over-compressed or excessively matted on the surface, as might be the case on a neglected lawn, great improvement can be brought about by spiking and forking. Spiking is usually carried out on larger areas by means of a spiked roller and on small areas by means of a board studded with nails, but these forms of pricking do not penetrate deeply enough. Machines capable of penetrating 3 to 4 inches without tearing are available and are more satisfactory. On small areas hand forking is practicable, though of course the work takes longer in proportion. Some will use the garden fork for this but there are specially designed forks for the purpose. A strong case can be made for the tubular fork in which the tines are shaped like apple corers and which removes cores of turf from the lawn. Many remarkable cases of improvement have been seen following the use of this fork on neglected turf. Not only does it relieve any hide-bound condition but it speedily results in new root development down the sides of the holes. Drought resistance

is increased and furthermore tubular forking is more effective in aiding water penetration since, on a very matted lawn, rain may fall and get no further than the top half-inch. The holes made by the tubular fork gradually grow over and though present are inconspicuous.

Mention may here be made of various surface operations. There is a tendency among lawn owners to think only in terms of mowing, rolling, and perhaps fertilizer treatment, but there are many other things that require to be done. We have mentioned switching to remove dew prior to mowing; drag brushing is very effective for scattering worm casts and on larger areas a mat or chain harrow may be used. Top-dressing should be worked in in the same way. Raking to remove creeping weeds is useful and close shaving of weeds like Clover and Yarrow with a small scythe-like blade is very effective.

In parts of the country with low rainfall even the most drought-resistant lawn will become brown and bare in summer unless artificial watering can be carried out. The important thing to realize when watering is that wetting the surface, though it may have a cooling effect, does not materially help the plants; the water must reach the root system if it is to do good. In this connection spiking is helpful, but if the lawn has been tubular forked the previous winter it will be found that artificial water can penetrate more satisfactorily. The best results are obtained by thoroughly soaking the lawn and not by light sprinkling at frequent intervals.

Many neglected lawns, coming in the category of those that have been mown and perhaps rolled but not fertilized during the war years, will be infested with mat weeds such as Selfheal, Mouse-ear, Chickweed, Pearlwort, Clover or flat weeds like Daisy, Plantain, Catsear and Dandelion. A great many of these can gradually be eliminated by the careful use of sulphate of ammonia and sulphate of iron. A commonly used mixture is:

3 parts sulphate of ammonia
1 ,, calcined sulphate of iron
20 ,, carrier

used at 4 oz. per square yard on five or six occasions during the growing season when the surface is damp and there is prospect of a sunny day to follow. Weeds like Dandelions and Catsear will not all be eliminated. Greater destruction can be done by spot treating with a stronger mixture, consisting of:

3 parts sulphate of ammonia
2 ,, sulphate of iron
5 ,, sand

Supplementary hand weeding will also be required. It will be noted that the above treatments do not make any contribution of phosphate or potash to the soil. At the moment these materials are debarred for this purpose, but it is hoped in due course that the embargo will be lifted and lawns that are being regularly treated will undoubtedly respond to the use of phosphate and potash. In many cases lawns are moss-ridden and if this is not due to excessive acidity, involving light liming, it will be found that the 3 : 1 : 20 mixture above gives excellent results, but better results will be obtained when the treatment can be supported by the use of phosphate and potash. Where weed control has been achieved dressings should be less frequent. Raking out of moss is sometimes advocated; where soft and mingled with grass, combing out may be successful but it may also cause much bareness, necessitating re-seeding and heavy supplies of good compost.

The question of manuring lawns is in part covered by the remarks above and although the embargo on fertilizers other than phosphate and potash is lifted, other materials are none too plentiful. Several useful forms of organic by-products may be mentioned, for instance, dried poultry manure, dried digested sewage of which there are some varieties fortified with phosphate, and other organic by-products. It has been found by experiment that long continued use of many of these organic materials, including dried blood and hoof and horn meal, tends to cause invasion by weeds like Pearlwort and it has also been shown that these can be checked by the occasional use of sulphate of ammonia.

It will be found on lawns infected with earthworms that the 3 : 1 : 20 mixture, primarily used for weed control, has a considerable retarding effect upon earthworm activity, as demonstrated by the number of casts. This method can hardly be regarded as a means of eradication. It is a fact, however, that worm-free lawns will remain remarkably free of worms if so treated and conversely that a worm-free lawn will become heavily infested if treated with lime or lime containing materials or with heavy or regular applications of organic fertilizers.

Where it is necessary to eliminate earthworms from a lawn several methods may be suggested. At the moment there is no mowrah meal available and this was the basis of the common pre-war worm killers applied to the surface and watered in. Many people to-day are using lead arsenate, and our experiments at St. Ives have shown it to be on the whole very successful. It is used at 2 oz. per square yard and has the advantage of destroying the worms below the surface. Copper sulphate may also be used and the method here is to dissolve 1 lb. of the granular crystals in 50 gallons of water and to apply this to 50 to 60 square yards of turf, during mild muggy weather if possible; great care is needed, otherwise damage will result. This method has the advantage of being inexpensive but in careless hands damage results. Our experiments with permanganate of potash showed this to be as effective as mowrah meal when used at the rate of ½ oz. in 1 gallon of water to 1 square yard, but unfortunately supplies of it are limited at the moment. Finally, there is perchloride of mercury which I think it better not to advise for the private lawn-owner in view of its very poisonous nature.

Two other types of lawn troubles may here be mentioned. First, turf diseases and, secondly, soil pests. When establishing a turf from seed it is often found that, after the seeds have been through the ground for about a week or ten days, circular rusty-looking patches appear, just as though someone had scattered some poisonous material over the surface; these are due to a disease of seedlings known as Cladochytrium. It is best dealt with by watering with Cheshunt compound solution or with dilute sulphate of iron solution. Established lawns that are receiving excessive amounts of nitrogen are liable to be affected, especially in September, by a disease known as Fusarium patch; it is particularly liable to attack annual meadow grass and to occur quite suddenly in mild muggy weather or in sheltered places. Experiments have shown that it can be controlled with various mercury compounds and prevented by spraying with malachite green and Bordeaux mixture. Where this disease occurs the system of manuring should be examined with a view to reducing the amount of nitrogen used in the future.

Besides earthworms, other pests of turf may occur. First, there is the leather jacket, grub of the crane fly, which can be controlled by extracting it with an emulsion of Orthodichlorbenzene and Jeyes Fluid, or by killing it in the ground by means of lead arsenate. Cockchafer grubs, fever fly grubs, and dung beetle grubs are also best dealt with by means of lead arsenate.

At the beginning of my remarks I said that it was a golden opportunity to effect general improvements to the lawn and I would like briefly to summarize some of the points to bear in mind. First, to avoid the various faults that I have already stressed, secondly to try and ameliorate heavy land, or on very light land to endeavour to improve it with water-holding materials. On lawns that have been made up by construction or by the fill and draw method, see that adequate soil is provided, especially at the draw end of the area. Then attention to drainage should be considered and, since during the war the trees overhanging our gardens have probably got somewhat out of hand, judicious lopping round the lawn sides is helpful. Especially is this so in towns since rainwater dripping from them is usually charged with dilute acids. In reconstructing our lawns attention must be paid to banks to see that they have adequate soil and that they are well drawn out and run gradually into the level part. A steep bank is most difficult to keep regularly mown and, if facing south, soon succumbs in dry periods. Grass verges deserve more attention. They are usually too narrow. Try the experiment of a really broad verge of 2 feet minimum, or perhaps more, and notice how much the effect will be improved.

It will, I hope, be realized that a lawn requires work just as other parts of the garden and that one cannot expect a perfect ornamental lawn that is also a playground for the children and their friends. In these cases it is best, I think, to let the children have first place or else to provide them, if there is room, with a separate area for play purposes. A wide expanse of lawn blended into the garden, unspoiled by beds cut into it, will be most gratifying in all ways, but we cannot achieve a good lawn without some expense. A good deal of common sense is needed in managing the turf and applying many of the points that I have stressed. Each case requires to be taken on its own merits but I hope my generalized remarks will be of some practical use.

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THE USE OF AERIAL PHOTOGRAPHS IN FORESTRY

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The use of aerial photographs in mapping is not exactly new, but their use in estimating standing timber is a comparatively recent development which is still in the experimental stage. Although ground photographs were employed in surveying to some extent before 1914, it was not until after the first world war, with the increased use of aircraft, further development of aerial camera and film, and improvement in the manufacture of apparatus for photo interpretation that much impetus was given to aerial mapping. Aerial photography has been tremendously stimulated by the military necessities of World War II. A great part of our successes in all threatres has been the result of good aerial photographic maps and interpretation made available to the invading forces by the aerial photographic units. As it applies to forest resources and management, the use of aerial photography should be greatly stepped up as soon as equipment and film, now available only to the armed forces, are made available to private enterprise and government agencies.

The airplane was first used in forest surveys, to locate specific areas and to obtain information about them. The information obtained by the observer as the plane flew over an area was fragmentary at best, and, unless the man sketching had considerable ability and experience, the data secured were only partly usable. If the plane flew high enough to permit a good view of the surrounding country it was usually so high that the observer could actually see and record only a small fraction of the data desired; if the plane flew low enough to permit a good view of the growth and topography, the terrain was traversed so rapidly that the observer, after glancing at his map to sketch in detail, looked out again to find himself in another water-shed or township.

Subsequently, it was found that a photograph could be used to get information, and since the information was available the day it was taken or a week or month later, the sketching methods that had served in the past became outmoded.

Methods of taking aerial photographs and of interpreting them have been developed in many fields and for many purposes, but probably to the least extent in forestry. Although the use of aerial pictures in North America dates back to the 1880's, it was not until about 1927, that they were used in Canada by the pulp and paper companies to obtain knowledge of their woodlands. Since that time, aerial pictures have been increasingly used in forestry, mostly for the mapping of forest types, rivers and lakes, and drainage divisions.

The following discussion pertains, in part, specifically to the north-eastern section of the United States, but much of it is applicable generally. Designation of types is usually broad. Three general types are recognized: softwoods, which means all conifers; mixed woods, which is a mixture of deciduous trees and conifers; and hardwoods. However, as the interpreter becomes more familiar with the country in which he is working and his experience in using the pictures increases, these major types may be broken down into more exact types and condition classes, such as sawtimber (old growth), white pine, possibly jack pine, second-growth hardwood, site classes, etc.

Types of Aerial Photographs

Several distinct types of aerial photographs, each with its own field of usefulness, are recognized. The two main types are the oblique and vertical. In vertical photography the camera axis is vertical, or nearly so, and the photograph produced is that of the territory immediately below the plane. The area covered is governed by the focal length of the camera lens and the altitude of the plane at the time of exposure.

Oblique photographs are made with the optical axis of the camera at an angle to the vertical. Those showing the horizon are termed high obliques; those not showing the horizon are termed low obliques. The use of oblique photography is somewhat limited in forestry, as high hills and mountain ranges mask out all detail on the far side of the ridges. However, flat country, such as northern Manitoba, may be photographed froms the oblique and the resulting negative may be rectified to the same plane as that of a vertical by projection printing. Because the oblique photographs cover a larger area than the vertical, the cost of aerial photography may be greatly decreased if they supply the desired results.

Since a vertical photograph provides the most complete and uniform picture of a landscape possible, it would appear to be the most desirable for woodland study. It not only has the necessary detail but it may be viewed stereo scopically, which is essential if topography is to be studied or tree heights determined.

The technique of actually making a forest inventory from aerial pictures alone was first developed by H. E. Seely of the Dominion Forest Service, Department of Mines and Resources, Ottawa, Canada. It has been employed in the United States for only a short time and has not yet been completely perfected. So far as the writer knows, only two agencies have used it extensively; the Northeastern Forest Experiment Station, Philadelphia, with headquarters for the survey itself at Wilkes-Barre, Pa., and the Brown Company, at Berlin, N. H.

The scale of the pictures and the type of forest study to be made must be decided upon before actual photography begins.

Scale of the Photographs

The scale of a vertical photograph, by the principle of similar triangles, may be expressed by the following equation: $S = \frac{f}{A}$ where S represents the scale fraction, or representative fraction; f the focal length of the camera lens, and A the flight altitude. Both f and A should be in the same unit of measurement, as feet or meters. On the other hand, the scale in feet per inch may be found by dividing the height or altitude of the plane in feet by the focal length of the camera in inches.

The scale of aerial photographs is subject to a number of variations which will be mentioned only briefly, since to elaborate on them would be rather time consuming and not particularly pertinent to this discussion. Most variations pertain to the study of aerial photogrammetry and not to aerial photography as it applies to forestry.

The difference in scale of pictures on adjoining flights is one of the varying elements, as altitude is one of the two factors in scale determination, and at present no altimeter or height-determining instrument is sensitive enough, calibrated finely enough, or sufficiently self-adjusting to atmospheric conditions, to enable a pilot to make all flights at absolutely the same elevation above sea level. The scale on individual pictures varies according to the topography, since the higher altitudes, being closer to the camera, are photographed on a larger scale than the lower surrounding area. This condition is commonly called displacement.

In rolling topography displacement is also caused by the fact that the film in the camera is a flat surface, while the subject being photographed is not; consequently the image on the negative is out of place as to its position on the ground. Furthermore, the outer edge of a photograph has a smaller scale than the center because the area is farther away from the camera. It is a rather complicated procedure to define displacement, so for the purpose of this article, which is to explain the use of aerial pictures in forestry, all we need to know is that by simple mathematical formulae displacement may be readily corrected.

Three other factors affect the scale. These are crab, tip, and tilt. Crab is caused by the inability of the plane, due to cross winds, to travel parallel to the line of flight; therefore, each exposure made while the plane is crabbed will be at an angle. Tip is caused by the plane's nose being above or below the horizontal. Tilt is caused by either wing tip being above or below the horizontal.

The most satisfactory scale depends upon the use to be made of the photographs, the method to be used in their interpretation, and the amount of detail desired. Merely for typing an area, a smaller scale may be used than when volumetric data are to be taken directly from the pictures. For forestry purposes, scales ranging from 600 to 1,800 or 1,900 feet to the inch are most commonly used; 1,900 feet per inch is about the smallest scale that can be utilized for a direct tree count with the photography and instruments now available.

Stereoscopy

For stereoscopic study, which is necessary for photoanalysis, each photograph must overlap the preceding photograph. The overlap usually required along the line of flight is 60 per cent.; and each flight should overlap the adjoining flight 30 per cent., not so much for stereoscopic study as for assurance of complete coverage. Stereoscopic coverage is not so important between pictures of adjacent flight strips, as practically all detail may be matched on stereo-pairs along the flight strip itself.

Stereoscopy plays an important part in air survey, both in the interpretation of air photographs and in plotting from them. For present purposes all that we need to know of its principles is that the impression of depth is secured by viewing two pictures with a stereoscope, one with the left eye and the other with the right eye. The impression formed at the sight centers of the brain is that of one picture having three dimensions so that each hill and valley appears as such, and individual trees may be seen standing erect and casting shadows on the ground.

Season of Year

The best season for taking the pictures depends upon the kind of detail that is to be obtained from them. If the photographs are to be used only to separate hardwood from softwood types, the most satisfactory season is winter with snow on the ground. These photographs give a clear outline of all softwood types, and to some extent mixed hardwood and softwood types. The pure hardwood types are readily seen, but the size of the timber is practically impossible to distinguish, especially on photographs with scales of 1,500 to 1,800 feet per inch. Shadows cast by the leafless hardwoods are confusing and also impossible to measure for height calculation, because the individual crown is so thin that the end of the shadow cannot be seen except possibly in the case of a large open-growth tree with a smooth flat snow surface beneath it.

Winter has photographic advantages over other seasons; then the atmosphere is the clearest with fewest clouds. A good photographic day is one that is cloudless, with little wind and no haze. With haze filters a small amount of haze is allowable, but too much tends to spoil the definition in the picture. Infra-red film may be used to cut haze, but as yet it is still in the experimental stage.

It is astonishing to find, as a result of weather records for the past two decades, how few days in each month are suitable for serial photography.

Fall photography, during the period of hardwood coloration, is the most suitable for hardwood study and volume estimates resulting entirely from pictures. At this period, the colored foliage appears gray or nearly white on the photographs, yet it shows distinct ceowns and shadows, which are essential when a tree-crown count is to be made. At the same time pure softwood types are readily distinguishable; in some cases softwood crowns may be seen within the hardwood types, though in such mixed types one of the disadvantages in an aerial estimate shows up. At the present time, it is impossible for the interpreter when observing the photographs, either singly or in stereoscopic pairs, to determine the amount or the composition of the understory because the hardwood overstory usually forms a thick canopy through which the understory cannot be seen, even from the plane itself when only a thousand feet up. The only method of determining this unseen volume of understory is by ground checking.

Spring photography, after the snow has gone, and late fall photography, before the snow falls, are similar and offer about the same advantages, but they provide more information about ground conditions than winter pictures. For planning logging operations or road construction, spring and fall have distinct advantages.

From a forestry standpoint summer photography is the least the least satisfactory. The uniform dark green of summer foliage tends to blend crowns into one plane, and makes individual crown count difficult and unreliable. The presence of white pine adds confusion by apparently reflecting about the same amount and kind of light as hardwoods to the negative, thereby making them resemble each other.

Determining Volume

Volume may be determined by the use of aerial pictures in several different ways. The most common method is to outline the desired forest types on the pictures, then to follow the conventional ground cruising methods of line of plots strip, or random sampling, using the photographs for control only. Thus, by eliminating the unmerchantable and inaccessible areas by photograph inspection, the field crews may reach the desired areas where sampling is needed with minimum expenditure of effort and time. Also, by taking the photographs into the field, the crew may be kept fairly well oriented at all times. In heavily timbered areas it is difficult to determine one's exact location; but in areas where there are brook branches, pastures, ledge outcrops, burns, or definite type changes, the crew may keep pretty much on line, and plot location may be readily checked. Even if the pictures are not carried into the field, office plotting is rendered more accurate by checking the pictures, as errors in chaining and bearing may be more

accurately adjusted, since they can be corrected there they actually occur.

The use of aerial pictures alone for making a volume estimate involves many changes from the ground cruising methods.

First, a plot of definite shape and size must be decided upon as in a ground cruise. One might think that a large plot of one half acre or an acre would be best where the crowns have to be counted, but with plots of this size it is difficult to remember which trees have been counted and which have not. Actually a one-fifth acre circular plot (radius 52.7 feet) has been found to be the most convenient. This plot must be converted to a circle at the same scale as that of the pictures. At a scale of 1 : 20,000 or 1,667 feet to the inch, this circle is approximately 1/16 of an inch in diameter.

The diameter in thousandths of an inch for various scales follows:

1 : 20,000 — .063 1 : 16,000 — .079
1 : 18,000 – .070 1 : 12,000 — .105

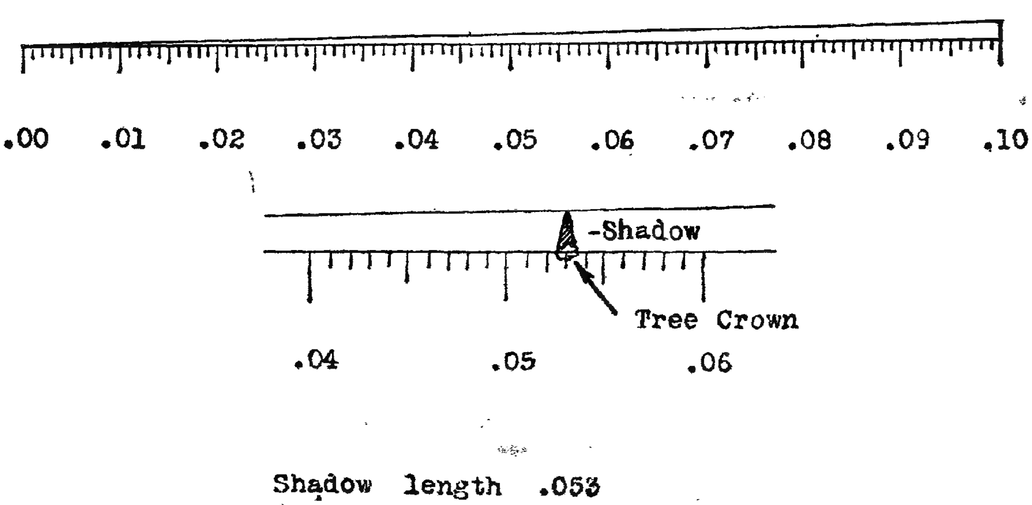
Circles may be inked directly on the photographs, but care must be taken not to puncture the paper or scratch the emulsion with the point of the bow pen. This method may be undesirable because it puts permanent circles on the pictures over areas in which further studies may be desired; also, the circle may fall over a point where a shadow will later need to be measured. In addition, the pen may change adjustment unnoticed, thereby resulting in possible serious errors in volume over an indeterminate portion of a prescribed area.

A better method is to put the circle on a transparent material, preferably glass, which may be placed over the photographs at the desired plot locations. These circles may be etched on the glass by first waxing the surface, then drawing the circles through the wax on the glass surface and applying hydrofluoric acid or a paste. This process is a slow and at best the circles may be irregular in shape.

Best results are obtained by drawing circles in black India ink on white paper at two or three times the desired diameter, and then photographing the circles, which in the process of making a positive can be reduced to the exact scale wanted and printed on a glass plate. *This method gives a clearly-defined black circle* on a clear glass plate. Later the glass may be cut up into small rectangular or square pieces with one or more circles on each square.

These small glasses have an emulsion on the side with the circle. After a month of use they become scratched and must be replaced. The replacement is a simple matter; once the negative is made any number of reproductions may be obtained in a short time. One process of photography may be eliminated by making the original drawing on a sheet of clear developed film.

A scale for measuring shadow heights in thousandths of an inch is constructed in like manner except that the finished product should be on flexible film rather than on glass. A simple scale may be made by drawing a right-angled triangle with a base of 5 inches and a height of 0·1 inch, and drawing in the hypotenuse. The base should then be graduated into inches and twentieths. The tree shadow is measured as shown in the figure below.



Upper scale for measuring shadow heights thousandths of an inch; lower scale for measurement of a tree shadow.

It is necessary to measure the tree shadow on the horizontal. If the tree is on a slope the shadow selected should be along the same contour as the base of the tree. Shadows usually cannot be measured on the same plot on which the tree count is taken because there must be an opening in the crown canopy large enough to see the full length of the shadows. It must be remembered that, with this system of aerial cruise, averages are used rather than individual measurements; thus, if a group of trees in which crown count is to be taken has no opening, it becomes necessary to obtain shadow measurements in immediately adjacent and similar stands in some opening such as a cutting line, burn, old road, or highway in which shadows can be measured. If several openings appear within the area a number of shadows should be measured and the average taken. This average shadow may have to be applied to a number of plot tallies. The use of average shadows for the volume estimate does not mean that individual shadows do not give accurate height measurements, because the height of individual trees, houses, or smoke stacks in the open can be accurately measured, but are used rather from necessity.

It is necessary to know the date, latitude, and longitude within one degree, and the exact time of the photograph exposure, to calculate tree heights from shadow measurements. A set of graphs computed for each month, day, and hour may be constructed to give a converting factor for each shadow length.

Volume Tables Are Based on Height

Volume tables used in aerial surveys, must be converted to volumes based on height rather than on diameter as in ground cruises; and tables must be made for various types of growth, such as old-growth hardwoods, second-growth hard-woods, softwoods, and in some cases pasture-growth softwoods. These tables are made for each 5-foot class beginning with what is considered the minimum merchantable height, and rising to the probable maximum height. For areas of sawlog or old-growth stands, these height classes should be again divided into 2½-foot classes. For instance, it was found that in northern hardwood stands, the volumes above the 70-foot class increased so rapidly that volumes for individual trees, doubled between the 70-foot and 75-foot class. To compensate for this increase, volumes were computed for trees 72.5, 75.0, 77.5, and 80 feet in height.

If an aerial survey is to be made for an area as large as a million acres or more, an average table may be made and applied to the whole tract. In this case, a great many heights in the different diameter classes and different types of growth should be taken from all over the area to be estimated. Even these tables will not be accurate for old-growth stands such as are found in northern New Hampshire and Maine. This condition is due to the fact that old-growth, large-crowned trees tend to increase in diameter at a faster rate than in height. Consequently, an old-growth tree with a total height of 80 feet may vary from 18 inches to 36 inches in diameter. Wherever possible old-growth areas should be delineated beforehand and special tables applied to them, thereby adjusting for this variation in diameter as well as allowing for defect, which may be studied and determined at the time the heights are taken.

After the volume tables are completed, the sampling circles and shadow scale obtained, and the shadow-conversion curves plotted, all that remains to complete the estimate is to count the tree crowns within the circle, determine the average shadow length, convert it to tree height, apply the given volume, and multiply by the number of trees. This technique may be carried on as intensively as is necessary for the desired estimate.

Mosaics for Control Maps

The use of mosaics as a means of control for making an estimate is new in forestry. A mosaic, as commonly understood, is merely an assembly of overlapping photographs put together and matched as closely as possible to make one picture of an area. As used in a timber estimate, the true mosaic is a photographic map made by joining up a series of vertical photographs, oriented for direction and rectified in printing for scale and for tilt and tip distortions by reference to ground control points. The controlled mosaic, as it is called, has some inaccuracies but is still far more accurate in detail than practically any type of control map used on a timber survey.

The mosaic sheet employed by the Brown Company is approximately 20 by 24 inches in size, and represents 5 minutes of latitude and longitude on the earth's surface, or approximately 15,000 acres. This area represents one-ninth of a 15-minute Geological Survey

map. A mosaic may be produced at any desired scale. A good usable scale for forest survey purposes is 20 chains, or 80 rods, to the inch (4 inches to the mile).

A mosaic resembles an enlarged vertical photograph but cannot be used for stereoscopic study. It is used the same as an ordinary map.

Detail may be transferred from a vertical photograph of varying scale to controlled mosaics, and *vice versa*, by various methods. Several types of projectors may be purchased or constructed for costs varying from a few dollars to several thousand dollars. Other equipment may be used such as the sketch master, camera lucida, or duoscope.

The duoscope is used considerably by the Brown Company. It is an instrument developed by the Dominion Forest Service of Canada for transferring detail from photographs to maps or mosaics at the same or different scales. This particular instrument is now undergoing improvement by the Dominion Forest Service. Various types of plotting machines are now manufactured to use with aerial pictures, but most of them are so expensive that only agencies expecting to make extensive use of the machines can afford to purchase them.

Future of Aerial Photography in Forestry

It is an established fact that the use of aerial photography is one of the quickest and cheapest means of securing data for timber maps and surveys. But it must be remembered that, regardless of the number of pictures available, their scale, the personnel using them, or the equipment employed, it is necessary to keep a constant field check by competent crews of all office computations derived from aerial photographs. However, with coming improvements in the equipment for interpretation of aerial photographs, further development and experimentation in various kinds of film, including infra-red and colour films and filters, the present sources of error will be greatly reduced. It is the sincere belief of the author that the future of aerial photography and its application to forestry and all allied fields is far-reaching and tremendous in scope. To-day, it is a new and useful forestry technique. Tomorrow will prove its indispensability.

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WARTIME FORESTRY IN NEW SOUTH WALES

By B. Farrell.

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The war has brought new emphasis to the importance of forests and forestry in New South Wales. With drastic curtailment of imports, acute timber shortages have been met by vastly increased output from our own forests. New uses have been found for many woods; for a multitude of purposes, substitutes from the forests of New South Wales have replaced, and often surpassed, the imported timbers. For special wartime uses, native timbers have been found to have superlative qualities. Coachwood for the Mosquito bomber is the outstanding and glamorous example: Coachwood forests have been exploited to the limits of transport facilities and organising ability, and so in varying degree have the remaining stands of most of our timbers been conscripted. Forestry has put both hands into the till and handed out its timber resources to wood-hungry wartime industry.

All this has meant that the wartime activities of the Forestry Commission have attracted a certain amount of notice. Overworked forestry officers have noted with a wry smile that their efforts in exploiting the forests have received more notice than did ever their efforts to build up the forest asset. They have realised that all this activity was further depleting an already sadly depleted and inadequate resource. They have regretted the lapse, during the war, of silvicultural operations which were restoring the productivity of previously over-exploited forests. Wartime timber-getting operations will greatly increase the leeway to be made up. The urgency of such matters as the restoration of forests on denuded catchment areas

has been swamped by the greater urgency of war. But foresters look forward to the day when these and similar jobs can be tackled in the manner which they demand.

Meantime, the job of organising wartime timber supply in this State has been a man-sized job, by any standards.

In the financial year 1938-39, the last before the war, New South Wales used 511 million superficial feet of sawlogs (equivalent to about 346½ million super. feet of sawn timber) and exported 27½ million super. feet. Of this 511 million, we imported 267 million super. feet—about half. Local production was 271½ million super. feet of which 135 million came from privately-owned timber lands and 136½ million from Crown forests (State Forests and Crown Lands under the care of the Forestry Commission).

By 1942-43, imports had shrunk to a mere trickle. Building restrictions and similar economies had reduced civilian consumption of timber, but immense quantities were required for war. Local production rose by 29 per cent. to 351½ million super. feet. Production from Crown forests rose to 239 million super. feet, a rise of 43%, while production from private property decreased by 17% to 111½ million super. feet.

In the first four years of the war, New South Wales forests produced 1,360 million super. feet of sawlogs, equivalent to about 817 million super. feet of sawn timber. Imagine a solid stack of timber as high as Sydney's tallest buildings, as wide as an average city block, and as long as Hyde Park from Liverpool St. to Queen's Square, and you have a pictorial idea of the quantity produced. Five-eighths of this came from Crown areas (nearly all from State Forests) and three-eighths from private property.

The decline in production from private property seems to indicate that this resource, over which no control has been exercised, is becoming exhausted. A good deal of timber still remains on inaccessible areas of alienated land, but individual owners of such timber cannot afford to make it accessible.

Much of the increased supply from State Forests has come from previously inaccessible, remote areas which form the State's last reserves of virgin timber. To make them accessible, 311 miles of first-class forest roads were built during the first four years of the war, and over 1,000 miles maintained in a condition to carry heavy timber traffic. It was necessary, in spite of opposition, to obtain in some cases higher prices for timber to meet the award costs of supply. Increased price rates—price—to—get—supply—have helped to mobilise New South Wales' reserves of timber to Australia's defence. The same principle, if extended, can make possible after the war the use of our last reserves while regrowth timber on treated, easily accessible forests reaches maturity.

In order to increase the regulated utilisation on Crown forest area, an increasing proportion of standing timber has been converted to logs by the Forestry Commission's own employees. Departmental conversion of logs in 1938-39 was 9 million super. feet. In 1942-43 it was 38 million, one-sixth of the total Crown forest output.

As a result of the general increase in timber sales from Crown forests, revenue of the Forestry Commission has increased from £224, 266 to £467,942 over the five-year period referred to above, and the forest wealth is now so much less. Reforestation ceased during the war period.

Forestry officers have handled a greatly increased job with no increase in their numbers. Field staff in 1938-39 numbered 109; in 1942-43 there were 104. An increase of office staff, mainly female, from 111 to 204 helped to handle the greatly increased volume of business. Decreased activity in reforestation activities is indicated by the fact that forest employees, in spite of their greater participation in actual timber supply, decreased in number from 1,312 in 1938-39 to 978 in 1942-43.

Wartime increase in wood use is a sign of things to come. Wood, the universal raw material, and one of the few replenishable national resources, will build the industries of the future. The wartime shortage is a warning. Conservation and reforestation must proceed apace after the war. A country without timber resources would be sorely handicapped in the economic world of the future.

The announcement, at the recent Premiers' Conference, of an allocation of between two and three million pounds per annum for forestry work in New South Wales in the immediate post-war period is encouraging. It is a sign of increasing public awareness of the vital role and the urgent tasks of the Forestry Commission.

Australian Engineer Annual 1944).